THURSDAY, MARCH 8, 1877

SCIENTIFIC WORTHIES

X.—HERMANN LUDWIG FERDINAND HELMHOLTZ

THE contributions made by Helmholtz to mathematics, physics, physiology, psychology, and æsthetics, are well known to all cultivators of these various subjects. Most of those who have risen to eminence in any one of these sciences have done so by devoting their whole attention to that science exclusively, so that it is only rarely that the cultivators of different branches can be of service to each other by contributing to one science the skill they have acquired by the study of another.

Hence the ordinary growth of human knowledge is by accumulation round a number of distinct centres. The time, however, must sooner or later arrive when two or more departments of knowledge can no longer remain independent of each other, but must be fused into a consistent whole. But though men of science may be profoundly convinced of the necessity of such a fusion, the operation itself is a most arduous one. For though the phenomena of nature are all consistent with each other, we have to deal not only with these, but with the hypotheses which have been invented to systematise them; and it by no means follows that because one set of observers have laboured with all sincerity to reduce to order one group of phenomena, the hypotheses which they have formed will be consistent with those by which a second set of observers have explained a different set of phenomena. Each science may appear tolerably consistent within itself, but before they can be combined into one, each must be stripped of the daubing of untempered mortar by which its parts have been prematurely made to cohere.

Hence the operation of fusing two sciences into one generally involves much criticism of established methods, and the explosion of many pieces of fancied knowledge which may have been long held in scientific reputation.

Most of those physical sciences which deal with things without life have either undergone this fusion or are in a fair state of preparation for it, and the form which each finally assumes is that of a branch of dynamics.

Many cultivators of the biological sciences have been impressed with the conviction that for an adequate study of their subject a thorough knowledge of dynamical science is essential. But the manner in which some of them have cut and pared at the facts in order to bring the phenomena within the range of their dynamics, has tended to throw discredit on all attempts to apply dynamical methods to biology.

We purpose to make a few remarks on a portion of the scientific work of Helmholtz, who is himself the most illustrious example not merely of extensive acquaintance with science combined with thoroughness, but of a thoroughness which of itself demands the mastery of many sciences, and in so doing makes its mark on each.

Hermann Ludwig Ferdinand Helmholtz was born August 31, 1821, at Potsdam, where his father, Ferdinand Helmholtz, was Professor of the Gymnasium. His mother, Caroline Penn, was of an emigrated English family. His father's means would not admit of his studying science otherwise than as a medical student. He therefore became a military surgeon, and continued in that position till the end of 1848, when he was appointed Assistant of the Anatomical Museum of Berlin, and Teacher of Anatomy at the Academy of Arts. In the following year he went to Königsberg, in Prussia, as Professor of Physiology. In 1856 he became Professor of Anatomy and Physiology at the University of Bonn; in 1859, Professor of Physiology at the University of Heidelberg; and, in 1871, Professor of Natural Philosophy to the University of Berlin.

It was during his career as a military surgeon that he published his celebrated essay on "The Conservation of Energy."

The science of dynamics has been so long established, that it is hardly conceivable that any addition to its fundamental principles should yet remain to be made. But in the application of pure dynamics to actual bodies a great deal remains to be done. The great work for the men of science of the present age is to extend our knowledge of the motion of matter from those instances in which we can see and measure the motion to those in which our senses are unable to trace it. For this purpose we must avail ourselves of such principles of dynamics as are applicable to cases in which the precise nature of the motion cannot be directly observed, and we must also discover methods of observation by which effects which indicate the nature of the unseen motion may be measured. It is unnecessary here to refer to the labours of the different men of science who, each in his own way, have contributed by experiment, calculation, or speculation, to the establishment of the principle of the conservation of energy; but there can be no doubt that a very great impulse was communicated to this research by the publication in 1847, of Helmholtz's essay "Ueber die Erhaltung der Kraft," which we must now (and correctly, as a matter of science) translate *Conservation of Energy*, though in the translation which appeared in Taylor's "Scientific Memoirs," the word *Kraft* was translated *Force* in accordance with the ordinary literary usage of that time.

In this essay Helmholtz showed that if the forces acting between material bodies were equivalent to attractions or repulsions between the particles of these bodies, the intensity of which depends only on the distance, then the configuration and motion of any material system would be subject to a certain equation, which, when expressed in words, is the principle of the conservation of energy.

Whether this equation applies to actual material systems is a matter which experiment alone can decide, but the search for what was called the perpetual motion has been carried on for so long, and always in vain, that we may now appeal to the united experience of a large number of most ingenious men, any one of whom, if he had once discovered a violation of the principle, would have turned it to most profitable account.

Besides this, if the principle were in any degree incorrect, the ordinary processes of nature, carried on as they are incessantly and in all possible combinations, would be certain now and then to produce observable and even startling phenomena, arising from the accumulated effects of any slight divergence from the principle of conservation.

But the scientific importance of the principle of the conservation of energy does not depend merely on its accuracy as a statement of fact, nor even on the remarkable conclusions which may be deduced from it, but on the fertility of the methods founded on this principle.

Whether our work is to form a science by the colligation of known facts, or to seek for an explanation of obscure phenomena by devising a course of experiments, the principle of the conservation of energy is our unfailing guide. It gives us a scheme by which we may arrange the facts of any physical science as instances of the transformation of energy from one form to another. It also indicates that in the study of any new phenomenon our first inquiry must be, How can this phenomenon be explained as a transformation of energy? What is the original form of the energy? What is its final form? and What are the conditions of the transformation?

To appreciate the full scientific value of Helmholtz's little essay on this subject, we should have to ask those to whom we owe the greatest discoveries in thermodynamics and other branches of modern physics, how many times they have read it over, and how often during their researches they felt the weighty statements of Helmholtz acting on their minds like an irresistible driving-power.

We come next to his researches on the eye and on vision, as they are given in his book on Physiological Optics. Every modern oculist will admit that the ophthalmoscope, the original form of which was invented by Helmholtz, has substituted observation for conjecture in the diagnosis of diseases of the inner parts of the eye, and has enabled operations on the eye to be made with greater certainty.

But though the ophthalmoscope is an indispensable aid to the oculist, a knowledge of optical principles is of still greater importance. Whatever optical information he had was formerly obtained from text-books, the only practical object of which seemed to be to explain the construction of telescopes. They were full of very inelegant mathematics, and most of the results were quite inapplicable to the eye.

The importance to the physiologist and the physician of a thorough knowledge of physical principles has often been insisted on, but unless the physical principles are presented in a form which can be directly applied to the complex structures of the living body, they are of very little use to him; but Helmholtz, Donders, and Listing, by the application to the eye of Gauss's theory of the cardinal points of an instrument, have made it possible to acquire a competent knowledge of the optical effects of the eye by a few direct observations.

But perhaps the most important service conferred on science by this great work consists in the way in which the study of the eye and vision is made to illustrate the conditions of sensation and of voluntary motion. In no department of research is the combined and concentrated light of all the sciences more necessary than in the investigation of sensation. The purely subjective school of psychologists used to assert that for the analysis of sensation no apparatus was required except what every man carries within himself, for, since a sensation can exist nowhere except in our own consciousness, the only possible method for the study of sensations must be an unbiased contemplation of our own frame of mind. Others might study the conditions under which an impulse is propagated along a nerve, and might suppose that while doing so they were studying sensations, but though such a procedure leaves out of account the very essence of the phenomenon, and treats a fact of consciousness as if it were an electric current, the methods which it has suggested have been more fertile in results than the method of self-contemplation has ever been.

But the best results are obtained when we employ all the resources of physical science so as to vary the nature and intensity of the external stimulus, and then consult consciousness as to the variation of the resulting sensation. It was by this method that Johannes Müller established the great principle that the difference in the sensations due to different senses does not depend upon the actions which excite them, but upon the various nervous arrangements which receive them. Hence the sensation due to a particular nerve may vary in intensity, but not in quality, and therefore the analysis of the infinitely various states of sensation of which we are conscious must consist in ascertaining the number and nature of those simple sensations which, by entering into consciousness each in its own degree, constitute the actual state of feeling at any instant.

If, after this analysis of sensation itself, we should find by anatomy an apparatus of nerves arranged in natural groups corresponding in number to the elements of sensation, this would be a strong confirmation of the correctness of our analysis, and if we could devise the means of stimulating or deadening each particular nerve in our own bodies, we might even make the investigation physiologically complete.

The two great works of Helmholtz on "Physiological Optics" and on the "Sensations of Tone," form a splendid example of this method of analysis applied to the two kinds of sensation which furnish the largest proportion of the raw materials for thought.

In the first of these works the colour-sensation is investigated and shown to depend upon three variables or elementary sensations. Another investigation, in which exceedingly refined methods are employed, is that of the motions of the eyes. Each eye has six muscles by the combined action of which its angular position may be varied in each of its three components, namely, in altitude and azimuth as regards the optic axis, and rotation about that axis. There is no material connection between these muscles or their nerves which would cause the motion of one to be accompanied by the motion of any other, so that the three motions of one eye are mechanically independent of the three motions of the other eye. Yet it is well known that the motions of the axis of one eye are always accompanied by corresponding motions of the other. This takes place even when we cover one eye with the fingers. We feel the cornea of the shut eye rolling under our fingers as we roll the open eye up or down, or to left or right; and indeed we are quite unable to move one eye without a corresponding motion of the other.

Now though the upward and downward motions are effected by corresponding muscles for both eyes, the motions to right and left are not so, being produced by the inner muscle of one eye along with the outer muscle of the other, and yet the combined motion is so regular, that we can move our eyes quite freely while maintaining

during the whole motion the condition that the optic axes shall intersect at some point of the object whose motions we are following. Besides this, the motion of each eye about its optic axis is found to be connected in a remarkable way with the motion of the axis itself.

The mode in which Helmholtz discusses these phenomena, and illustrates the conditions of our command over the motions of our bodies, is well worth the attention of those who are conscious of no limitation of their power of moving in a given manner any organ which is capable of that kind of motion.

In his other great work on the "Sensation of Tone as a Physiological Basis for the Theory of Music," he illustrates the conditions under which our senses are trained in a yet clearer manner. We quote from Mr. Ellis's translation, p. 95:—

"Now practice and experience play a far greater part in the use of our senses than we are usually inclined to assume, and since, as just remarked, our sensations derived from the senses are primarily of importance only for enabling us to form a correct conception of the world without us, our practice in the observation of these sensations usually does not extend in the slightest degree beyond what is necessary for this purpose. We are certainly only far too much disposed to believe that we must be immediately conscious of all that we feel and of all that enters into our sensations. This natural belief, however, is founded only on the fact that we are always immediately conscious, without taking any special trouble, of everything necessary for the practical purpose of forming a correct acquaintance with external nature, because during our whole life we have been daily and hourly using our organs of sense and collecting results of experience for this precise object."

Want of space compels us to leave out of consideration that paper on Vortex Motion, in which he establishes principles in pure hydrodynamics which had escaped the penetrative power of all the mathematicians who preceded him, including Lagrange himself; and those papers on electrodynamics where he reduces to an intelligible and systematic form the laborious and intricate investigations of several independent theorists, so as to compare them with each other and with experiment.

But we must not dwell on isolated papers, each of which might have been taken for the work of a specialist, though few, if any, specialists could have treated them in so able a manner. We prefer to regard Helmholtz as the author of the two great books on Vision and Hearing, and now that we are no longer under the sway of that irresistible power which has been bearing us along through the depths of mathematics, anatomy, and music, we may venture to observe from a safe distance the whole figure of the intellectual giant as he sits on some lofty cliff watching the waves, great and small, as each pursues its independent course on the surface of the sea below.

"I must own," he says, "that whenever I attentively observe this spectacle, it awakens in me a peculiar kind of intellectual pleasure, because here is laid open before the bodily eye what, in the case of the waves of the invisible atmospheric ocean, can be rendered intelligible only to the eye of the understanding, and by the help of a long series of complicated propositions."—("Tonempfindungen," p. 42).

Helmholtz is now in Berlin, directing the labours of able men of science in his splendid laboratory. Let us hope that from his present position he will again take a comprehensive view of the waves and ripples of our intellectual progress, and give us from time to time his idea of the meaning of it all.

J. CLERK MAXWELL

THE UNIVERSITIES BILL

PEOPLE'S notions of "reform" differ very much according to their interest in or knowledge of the kind of thing to be reformed. At present there is much talk of university reform, but there is really no proposition before the public for reforming the universities. The Government Bill is simply intended to adjust certain parts of the machinery of the ancient corporations at Oxford and Cambridge and to oil the wheels which with the lapse of time have become rusty. There is no intention to make Oxford and Cambridge what they were three centuries ago—namely universities in the sense in which the word "university" is applied (excepting the cases of London and Durham) to every other institution claiming the title in civilised Europe. The historic process by which the endowed boarding-houses at Oxford and Cambridge known as colleges fell into the hands of the clerical party, and subsequently became possessed of the sole control of the university, suppressing the higher Faculties, with the exception of the Theological, and driving from the university all students but those who could afford to make a ruinous annual payment to the cooks, butlers, scouts, and tutors of one college or another in exchange for indifferent board and lodging and a "religious education" in a school-boy's horn-book, under the disciplinary system devised by the Jesuits, is *not* to be reversed. No re-constitution of the Faculties—the absolutely essential step in the reformation of decayed universities—is proposed, nor is the Bachelor-of-Arts curriculum to be relegated to its proper place—the preparatory schools. The colleges are still to have it all their own way, are to be allowed still to compete with one another in buying at the rate of 100*l*. a year the chances of distinction which a promising school-boy can give by entering his name on the college-books; they are still to pursue the fruitless task of training these youths so as to obtain for the college the largest possible number of "first classes" in an examination arranged and conducted by the colleges (whose representatives far outnumber the professoriate) in subjects and methods which the student should either have dropped at the threshold of the university or should pursue in a spirit and with a thoroughness incompatible with the conditions of these competitive examinations. Prize fellowships awarded by competitive examination are still to be the incentives to these mercenary studies on the part of the young men; the university professor, even though he may be multiplied by two, is still to occupy the ambiguous position which is at present his lot—by right the director of the studies connected with his chair, but, in fact, shorn of the privileges and functions of his office through the eager competition of colleges for examination honours and tutorial fees. Worse than all, the ridiculous "matriculation" examinations are *not* to be superseded by a thorough university matriculation examination—to the want of which the disgraceful inefficiency of school-teaching in all our public schools is due.

It is true that it is only within the last quarter of a century that the full supremacy of the Theological Faculty in Oxford has been attained by the practically complete effacement of the Medical Faculty, the Regius and Clinical chairs in which are now held by one professor, who appears to have acquiesced in the total cessation of medical study in Oxford. It is also true that within the same period the Faculty of Laws has made a partial reappearance, and musters a few non-professional students, whilst under the stimulus afforded by competitive examination and prize fellowships, something more in quantity than, but still identical in kind with, the class-work taught at school to boys of from fifteen to eighteen years of age, is now sedulously driven into the undergraduate's brain by his college tutors and lecturers. It will also be adduced by the apologists of the present university *régime*, that over 80,000*l*. have been spent at Oxford on a palatial edifice for the encouragement of the long-neglected studies which are ranked as physical science. It should, however, be thoroughly understood that the sum in question has been primarily devoted to the production of an architectural monstrosity, the University Museums, which though pleasing to the æsthetic persons who invented it, does not provide the accommodation which the subjects require, nor even so much as could, in the absence of æsthetic muddling, have been obtained for a fourth part of the sum quoted with so much assurance.

The actual facts which are given below show what is the constitution of the University of Oxford in the way of professors, college-teachers, and students, and to what studies they respectively devote themselves. These figures entirely refute Mr. Lowe's recent statements to the effect that whilst the honour-man at Oxford has a good education, and the pass-man a very bad one—the pass-men far outnumber the honour-men. Clearly Mr. Lowe had not troubled himself to ascertain the facts before making his attack, which was intended to show the danger of allowing the Owens College to become a university. Mr. Lowe's conception of a university is limited by the model of that which he represents, and accordingly there is little comfort to be derived from his attacks on Oxford for those who believe in "the university" as it exists in the great German home of universities.

All that has been written and said within the last three months on the university question shows that there is a most serious ignorance among our public men of what universities are, what they can do, are doing, and how they do it, both in Great Britain and abroad. Only two members of the House of Commons, Dr. Lyon Playfair and Mr. Grant Duff, appear to have so much as an elementary acquaintance with the subject on which they are about to legislate. Even Mr. Goldwin Smith, who has returned to England full of wisdom gained in the Far West, expresses his belief in the college system because, forsooth, certain mushroom institutions in America which are defective as universities, have no colleges or boarding-houses. Had Mr. Goldwin Smith travelled east instead of west, he might have formed other and sounder conclusions after a study of German universities.

Under these circumstances, though it is a matter of profound concern, it is not surprising that the Government Bill contemplates no change which will re-create Oxford and Cambridge as universities. They will remain each a congeries of finishing schools for the sons of the wealthier classes—where a man may learn, as Dr. Lyon Playfair has said—how to spend a thousand a-year, and to spend it with some discretion, but not how to earn a thousand a-year—how to make himself a useful member of society valuable at that rate.

To fit a man for a career in life, the task which is undertaken by every other university worthy of the name, is absolutely what Oxford and Cambridge refuse to do, and what legislators ought to force them to do. Poor men, or men of moderate means, can only afford to send their sons to an English university in order that they may become clergymen or schoolmasters, or on the chance that, as in the Chinese mandarin selection, they may, by submission to the tyranny of a competitive examination, win a prize fellowship.

Those who desire and see in the future a true university reformation—having nothing favourable to their views to expect from the action of the Commissioners appointed without definite instructions by the present Government Bill—have none the less much to fear and to combat. It is admitted on all hands that the powers of the Commissioners are very great, though they are not *definitely* instructed as to how they are to employ those powers. Practically it will come to this, that the Commissioners will simply empower the resident fellows of colleges to do what they have long wished and sketched out, namely, to marry and settle down permanently in the university as college lecturers and tutors. This boon will be granted to the colleges in exchange for an immediate ten and a prospective fifty thousand a year, which will go to paying for new university buildings and for some new (as well as additions to the stipends of some old) professorships.

The new professors will be in the same ignoble position as the old ones, since no change in the constitution of the government of the university is contemplated, and there is no reason to suppose that they will make the university more remarkable for research and less remarkable for apathy, than does the existing body. The clerical restriction on headships of colleges—sinecures varying in value from 1,000*l*. to 2,000*l*. a year—*may* be removed by the Commissioners, but is not necessarily to be so; nor is provision made for abolishing headships altogether. The nature of the duties of the college lecturers and tutors who will become a more formidable body than ever, when allowed to root themselves with family surroundings, will not be regulated by the Commissioners, nor the subjects which they shall teach. At the same time the non-resident fellows will have their term of tenure limited, and their influence in college government will be diminished, even if they are not altogether excluded from a share in it. The result of these changes will be greatly to strengthen the college system of preparing pupils for the examination race-course, and to render it more difficult than ever to remove the injurious antagonism which at present prevents any real co-operation among the colleges for the common good of the university. The cessation of this antagonism might have been effected once and for all by empowering the Commissioners to reconstitute the Faculties, and to combine in them equally

all college teachers and professors, to be organised into a series of consentaneous teaching bodies, one in each Faculty.

In sketching what seems a possible and satisfactory scheme for the university reform of the future, it is desirable first of all to ascertain what sum of money can be spent with advantage in a single locality like Oxford; and, secondly, what can be reasonably done with the surplus funds now administered through Oxford. It appears that about 400,000*l.* a year may be reckoned as the immediate prospective revenue of the colleges and university of Oxford. Of this, 150,000*l.* a year would nobly endow a reformed Oxford, leaving 250,000*l.* a year for other purposes. The University of Oxford is generally regarded as a *place*, whereas it is essentially a *corporation*. Whilst the University could not with benefit dispense more than 150,000*l.* a year within the city of Oxford, there is no reason why it should not have a series of institutions connected with it in London, or even in other great cities. The universities founded in this way by the surplus revenues of Oxford and Cambridge in London, Birmingham, Manchester, Leeds, and Bristol, should be equally endowed with the parent universities, and might form as do the German universities a series of co-operating institutions from one of which to another the student could pass as the special direction of his studies might determine, and the professorial positions in which (of graduated value) would furnish a ladder to be climbed by those who devote themselves to the professorial career.

Leaving the question aside, as to the ultimate disposal of surplus revenues, there is no doubt that with the introduction of a system of professorial teaching, combined with a rigid pass examination, and the removal of the baneful "competition for honours," Oxford could be maintained in external appearance much as it is with 150,000*l.* a year of endowment. The college buildings would remain as boarding-houses and would have to compete as such with the ordinary lodgings in the city. There would be a limited number (two or three in each college) of domestic "tutors" or house-masters to preserve order and give advice to the students resident in colleges, whilst the entire teaching would be performed by the greatly-increased professorial staff.

With or without the more radical points of this change, any Bill professing to reform Oxford and Cambridge ought to embrace the following provisions, or some at least of them; none of them are comprised in the Government measure.

1. The creation of new professorships and their arrangement with the old ones in Faculties (say Theology, Law, Medicine, Physical Science, and Literature), on as complete a scale as the most fully-developed German university presents—say Leipzig—where with a total revenue of 50,000*l.* a year the University has 115 professors as against 43 in Oxford.

2. The giving of the sole control of the curriculum of study in each Faculty to the official members of that Faculty, together with the sole right to appoint examiners and to elect to vacant professorships. The existing "Boards of Studies" might without difficulty be developed into the required Faculties.

3. The exclusion of all non-resident graduates and of persons not officially recognised as teachers (members of Faculties) from participation in university government.

4. The imposition of a *thorough* matriculation examination (to embrace the elements of physical science and other modern studies) on all students seeking admission to the university; the subjects of examination and standard to be arranged and determined by a committee of the faculties in concert with other great national educational bodies.

5. The abolition of "college monopoly," and the introduction of free trade in the boarding and the teaching of undergraduates—firstly, by permitting an undergraduate (whether enjoying a college scholarship or not) to reside where he may find the cheapest and best accommodation either in or out of college; and secondly, by prohibiting any compulsory exaction from him of attendance on, or payment for, any teaching which he does not voluntarily select as the most likely to add to his knowledge, or to enable him to pass with credit the only examination he would have to undergo, viz., the "pass" examination of the faculty, admitting him to the degree of Bachelor or of Master.

6. The institution of a Doctor's degree to be given in the Faculty of Science, and in that of Literature after the degree of Bachelor, on presentation by the candidate of an original thesis to be approved by the Faculty, and *to be published* (publication being indispensable).

7. The annual assignment from surplus revenue of some thousands a year to each Faculty to be dispensed by them in special missions, explorations, travels, and researches.

8. The general control by the State Government of the finances and public acts of the university. The continual control of a richly-endowed corporation by the State is an indispensable safeguard.

9. The prohibition of the employment of any collegiate or university funds for any ecclesiastical purpose or for any other non-academic purposes.

10. The removal of all religious tests in connection with any office (professorial or other) held in the university or colleges, as well as the abolition of *all* compulsion in regard to religious observances such as are now exacted from undergraduates.

To make all or the major portion of the changes here advocated would be truly to change the character of our English universities. They would be restored to national uses as universities worthy of the name; they would cease to be the "Kindergarten" of the wealthy classes, to whom they belong by no right, and by whom they have long been appropriated and misused.

APPENDIX.

Facts with regard to Teachers and Students in the University of Oxford, derived from the "University Calendar" of 1875.

There are about 2,400 undergraduates, or persons *in statu pupillari*, on the College and University books; 400 of these graduate in each year, the average time spent in the University being over four years.

Of these 75 per cent. read for honours in the various schools or Faculties, whence it appears that there are about (probably less than) 1,800 students in Oxford reading for honours. Of these 1,800 it appears that 33

per cent. read for the school of Literæ Humaniores (Philosophy, Classical History, and Philology), 20 per cent. for the school of Modern History, 17 per cent. for the school of Theology, 15 per cent. for the school of Law, 7 per cent. for the school of Mathematics, and only 6·5 for the school of Physical Science.

Of the 2,400 undergraduates 24 per cent. hold college scholarships or exhibitions varying in value from 30*l*. to 100*l*. a year, exclusive of scholarships or exhibitions granted by external bodies.

There are at this moment 360 fellows of colleges, exclusive of heads and professors, of whom 140 (out of a total of 160 college lecturers and tutors) are resident and engaged in teaching. The average endowment of a fellowship is 250*l*.

There are thirty-seven University professors and six University readers or assistant professors, of whom nine give no definite courses and have no pupils. They are distributed in subjects thus: Theology, five; Medicine, two; Law, four, and a reader; Lit. Human. seven, and a reader; Mathematics, three; Physical Science, seven, and four readers; Modern History, three, and a reader; Fine Art and Modern Languages, seven.

Taking the total number of teachers, both collegiate and professorial, and the total number of honour-students, according to the subjects which they respectively teach and pursue (which subjects may be ascertained from the calendar), we find that in Literæ Humaniores the proportion of collegiate and professorial teachers to students is 1 : 5·5; in Mathematics, 1 : 6; in Physical Science, 1 : 7; in Modern History, 1 : 5; in Law, 1 : 15·5.

Estimating the average annual income of a college lecturer or tutor at 500*l*., we find that 75,000*l*. is the sum required to pay at this rate for 150 such persons. This sum is exactly what the scholarship fund (40,000*l*.), plus 140 fellowships of 250*l*. each amounts to; so that, practically, the teaching in Oxford colleges is paid for, not by the parents of undergraduates, but by a portion of the collegiate endowments—to wit, the scholarship fund and two-fifths of the fellowship fund.

The statement recently made by Sir John Lubbock in the debate on the Universities Bill in the House of Commons, to the effect that Oxford practically has done nothing for the development of the study of physical science, is amply justified by the above figures; there are only seven professors and four readers of all the various physical sciences in Oxford; only one twenty-fourth of the undergraduate students in the place pursue the study of physical science; *and of all the three hundred and sixty fellowships in the various colleges only five* are held by persons (exclusive of professors) who have been elected to them in consideration of their attainments in physical science. In four more fellowships the application of mathematics to physics has been allowed to count in establishing a student's claim to such fellowship.

The public schools teach physical science to so few boys, and teach it so inefficiently, that there are quite as many scholarships for excellence in this subject offered to the matriculating students as there are worthy candidates. The fact that the public schools never teach physical science to all their pupils and only as a rule to the dullest boys in the school, who are carefully selected for this study on account of their failure in classics and mathematics, is simply due to the fact that neither the colleges nor the university introduce any branch of physical science into any one of their compulsory examinations. And this fact is further explained by the fact that the college lecturers and tutors, and even the heads of houses, are, with few exceptions, men who have been schoolmasters, or who hope to be so, and who are identified in every way with the pedagogic profession.

In fact, using the term without any offensive implication, the College authorities, together with the schoolmasters, form a "ring" whose interest it is to suppress a class of studies of which they are themselves ignorant. The university professoriate, which should act as a higher body, to control and stimulate the pedagogic class of teachers, is, as already mentioned, a nonentity. There is no such higher power—the "University" is ridden over rough-shod by the "Academy for Young Gentlemen."

AN OXFORD MAN

THE BASQUES

Essai sur la Langue Basque. Par F. Ribary. Traduit du Hongrois par J. Vinson. (Paris: F. Vieweg, 1877.)

Basque Legends. By W. Webster. (Griffith and Farren 1877.)

THE Etruscans perhaps excepted, there is no race that has had a greater attraction for the ethnologist and the student of language than the Basque. Defended by the mountain-fastnesses of the Pyrenees, with peculiar physiognomy, language, and manners, they seem to be the last waif and stray of a people and family of speech which have elsewhere disappeared. Whence did they come? and what is their kinship? are the two questions which have long been discussed warmly and to little purpose. Are we to regard them as the descendants of the ancient Iberi, and find their traces, with Wilhelm von Humboldt, in the local names of Spain, of Sicily, and of Southern Italy, or are we to bring them from Africa on the one side, or from America on the other, or finally let them drop from the clouds, or grow up spontaneously on their native soil? Certain it is that languages like Basque were spoken in the north of Spain under Roman rule; at least, the town called Graccuris, in honour of Tiberius Gracchus, is a genuine Basque compound of *iri* or *hiri* "city," like Iria Flavia, "the Flavian burgh." Exclusive of emigrants in South America, the present Basque population amounts to about 800,000, of whom 660,000 are Spanish, and 140,000 French. Their language has little resemblance to any other known tongue, whether ancient or modern. Erro claimed for it the privilege of having been spoken in Paradise; and Larramendi proudly named his grammar (1729) "El Impossible Vencido"—"The Impossible Conquered." The native works upon the language, however, were all tainted with mysticism and want of scientific method, and it is only of late years that this interesting speech has been examined in the light of science and exact scholarship, and grammars composed which treat it in a rational way. Materials for the work have been prepared by the researches of Prince Lucien Bonaparte, who has accurately mapped out the several dialects of the language, has noted their individual characteristics and

peculiarities, and has actually discovered some fast-perishing dialects which had hitherto remained unknown. His magnificent work on the Basque verb has, it may be said, created the scientific philology of the language.

Basque, or Eskuara (probably meaning "mode of speaking"), as the Basques themselves call it, is an agglutinative tongue, postfixing, for the most part, the sounds which express the relations of grammar. The grammar would be simple were it not for the verb, at once the wonder of native writers and the despair of foreign linguists. The verb incorporates the pronouns, having a different form for "I have," "I have it," "I have it for you," &c., as well as (in some dialects) for addressing a woman, a man, a superior, and an equal. It possesses also three voices, two primary tenses, at least five moods, and more than one participle or infinitive. When analysed these forms turn out to be amalgamations of the verbal stem with various pronouns and modifying particles, but their origin is so obscured by phonetic decay, and their number is so immense, that we cannot much wonder if, according to the legend, the devil, having spent seven years at Burgos in the vain attempt to learn the language, was at last obliged to leave the Basques to their primitive simplicity and virtue. The eight principal dialects —Labourdin, Souletin, Eastern Bas-Navarrais, Western Bas-Navarrais, Northern Haut-Navarrais, Southern Haut-Navarrais, Guipuscoan, and Biscayan—differ a good deal from one another, and the three sub-dialects of Spanish Basque—Roncal, Aezcoan, and Salazarese, have yielded to Prince Bonaparte interesting archaic forms and words. It is unfortunate that our knowledge of Basque does not reach back further than 1545, when the first book in the language—the "Poems of Dechepare"—was printed, and a restoration of earlier grammatical forms must therefore rest solely upon a comparison of the existing dialects.

The grammar of the Hungarian professor, which M. Vinson has translated into French, is an extremely good one, and its value has been increased by the introduction he has prefixed to it, as well as by the notes he has added by way of supplement and correction, and by a very useful and almost exhaustive Basque bibliography he has appended at the end. These notes will form the subject of an article Prince Bonaparte is preparing for publication. Prof. Ribary's exposition of the intricacies of Basque grammar is singularly clear, and I know of no work from which the foreign student could gain a better insight into the machinery of the verb or a better key to its multitudinous forms. Certain of these are compared with corresponding forms in Magyár, Vogul, and Mordvinian, which, like the Basque, are able to incorporate the objective pronoun. The volume may be heartily recommended for both scientific and practical purposes.

While the Basque language has been attracting so much attention, the equally interesting and important folk-lore of the country has been almost wholly neglected. With the doubtful exception of Chaho, none of the Basque legends were "even noticed till within the last two years, when M. d'Abbadie read the legend of the Tartaro before the Société des Sciences et des Arts de Bayonne, and M. Cerquand his 'Légendes et Récits Populaires du Pays Basque,' before the sister society at Pau." Mr. Webster's book, therefore, is doubly welcome, consisting as it does of tales and legends written down from the lips of the narrators, and literally translated into English with the co-operation of M. Vinson. Mr. Webster has divided the stories into (1) Legends of the Tartaro, (2) of the Heren-Suge, or Seven-headed Serpent, (3) animal tales, which are neither fables nor allegories, (4) legends of Basa-Jauna, Basa-Andre, and other Lamiñak, or fairies, (5) tales of witchcraft, (6) Contes des Fées, and (7) religious legends. The Tartaro is a one-eyed Cyclops, and what is told about him will interest classical scholars. He lives in a cave among his flocks, and is blinded with a red-hot spit by the hero, who contrives to escape by the help of the unsuspecting sheep. In some versions the story of the talking ring is combined with that of the Cyclops, and in one form of the legend communicated to me by M. d'Abbadie, and alluded to by Mr. Webster, the hero is made to fight with a body without a soul. Grimm has quoted analogous stories to that of the Cyclops, among the Oghuzian Turks, Karelians, and others, and M. d'Abbadie heard an almost exactly similar one in Eastern Africa, while Mr. Moseley has pointed out to me that the Chinese also have their "one-eyed people who live to the east of Chuk Lung, and have one eye in the centre of the face." (See my "Principles of Comparative Philology," second edition, pp. 321–323, and for an account of a Mongolian Cyclops, Mr. Howorth, in the *Journal* of the R.A.S., vii., 2 (1875), p. 232.) It is within the bounds of possibility that the Greek myth of the Cyclops may have been borrowed by the colonists in Sicily or the voyagers to Tartessus from some ancient Basque population. However this may be, the legends of the seven-headed serpent connect themselves very strikingly with Western Asia. Accadian mythology had much to tell of "a seven-headed serpent," the dragon of Chaos, which tempted man to sin and waged war with Merodach, the Chaldean Michael. The Indian Vritra has but three heads, like the Orthros, the Kerberos, the Ekhidna, and the Khimæra of the Greeks, but it is at least curious that Orthros, with his master Geryon, was localised at Cadiz in the later days of Greek mythology. Basa Jauna, again, "the wild man of the woods," with his wife Basa-Andre, though once represented as a kind of vampire, is usually described as a sort of Satyr, reminding us not only of the classical Pan, but of the far older Chaldean Hea-bani, the friend and councillor of the Babylonian Herakles. Basa-Andre, says Mr. Webster, "appears sometimes as a kind of mermaid, as a beautiful lady sitting in a cave and 'combing her locks with a comb of gold,' in remote mountain parts."

On the whole, however, there is very little that is native in these Basque legends, at least so far as their origin and texture are concerned. As Mr. Webster has noticed, the resemblance of many of them to the Keltic stories of the West Highlands is too minute to be the result of accident, while a large part of them is familiar to us in a French or even a German form. How the Basques could have borrowed Gaelic stories is at present not easy to explain; it is more probable, however, that this took place through maritime intercourse at a comparatively recent period than at some remote date when the ancestors of the Kelts and the Basques may be supposed to have lived in close proximity. The impression left upon the mind by the legends Mr. Webster has collected is that the Basques are neither imaginative nor original, and

this is borne out by what he tells us of their unreasoning "adherence to what they believe to be the text of these old tales. 'I don't understand it, but the history says so;' 'it is *so;*' 'the story says so;' was positively affirmed again and again." This conservatism accounts for the survival of so many pagan ideas and customs among the people, among which the legends themselves may be reckoned. The latter are believed like "the histories of the Bible, or the 'Lives of the Saints.' In fact, the problem of reconciling religion and science presents itself to the Basque mind in this strange guise—how to reconcile these narratives with those of the Bible and of the Church. The general solution is that they happened before the time of which the Bible speaks, or before Adam fell. They are *lege zaharreko istorriguak*—'histories of the ancient law'—by which is apparently meant the time before Christianity. 'This happened, sir, in the time when all animals and all things could speak,' was said again and again by the narrators at the commencement of their story;'" a statement which curiously fits in with a similar belief among the Bushmen. Altogether Mr. Webster has produced a most interesting book, and we hope that the welcome given to it may induce him to make it but the first instalment of other researches among the folk-lore of the Basques.

A. H. SAYCE

OUR BOOK SHELF

French Accent. By A. H. Keane. (Asher and Co., 1877.)

THIS is an excellent and useful little pamphlet, in which the author claims to have discovered and formulated for the first time the laws which regulate French accentuation. Putting aside the tonic accent which usually falls on the last syllable of a word, and corresponds with the toned syllable of the Latin or Italic original, we have three accents: the acute, the grave, and the circumflex, which Mr. Keane terms respectively the euphonic, the grammatical, and the historical. The circumflex denotes the loss of a sound, as do also the acute when on initial *e*, and the grave when on final *e*. The grave is alone employed grammatically to indicate the grammatical changes of words, and Mr. Keane lays down the two rules that "*e* followed by grammatical *e* mute, one consonant intervening, takes the grave accent," and that "every unaccented *e* followed by one consonant not final is mute." Mr. Keane shows himself well acquainted with the latest philological researches into the French language, and both pupil and teacher will find great assistance from his attempt to introduce law and order into the nature and position of the French accents. However, he is not altogether the first in the field, and it must be remembered that the philological ignorance of those who have stereotyped the use of the accents has caused it to be somewhat arbitrary. The Neufchatel Bible of 1535 has no accents, and the first to employ them regularly, though somewhat capriciously, was Jacques Dubois, in the sixteenth century. In "An Introductorie for to Learn French trewly," published by Du Guez, in London, probably about 1560, the accents are written below the line.

Étude sur la Dégénerescence Physiologique des Peuples Civilisés. Par M. Tschouriloff. (Paris: Leroux, 1876.)

THIS is a careful and conscientious discussion of a class of statistics that have never been so carefully discussed before, and have in consequence been interpreted by different writers in very different senses. There are two questions, both of which M. Tschouriloff answers in the affirmative, but which perhaps he does not always separate as clearly as could be wished; the one is whether the French and other civilised nations are deteriorating in their *physique*, and the other whether their deterioration is due to the abstraction of able-bodied men to serve and perish in the army. He has no doubt as to the deterioration in France, Sweden, and Saxony; thus, in the latter country, the number of men too infirm to serve as conscripts has largely increased of late years; in 1832–36, one-third of the men were rejected; in 1850–54, one-half. He quotes numerous medical authorities, whose opinions are printed in the article, "Recrutement," in the *Dictionnaire Médical*, to show the evil effects of industrial occupation on the health of factory workmen, and alludes to many other interesting facts of the same nature. But the bulk of the work is occupied in tracing the effects of the conscription on the French race. The statistical examination of the returns of the medical examiners is of a necessity very complex, allowances and corrections having to be made on many grounds. Even so apparently simple a problem as that of determining the amount of vigour abstracted from a population by the absence of a given fraction of them during a limited period, such as that of the great war, is in reality very complicated, and requires the free use of tables of mortality and of fecundity for different ages. The upshot of the author's inquiries is to show that the amount so abstracted is much greater than appears at first sight to be the case. He therefore ascribes a very seriously damaging effect to the vigour of a population by the carrying on of great wars. It is truly sad to read the statistical tables of the increase in France of a long series of such hereditary diseases as scrofula, hare-lip, varicose veins, paralysis, madness, and skin maladies, due in large part to the propagation of the race by men who had been rejected as too infirm to serve in the army, and to so many of the healthy men having been destroyed or displaced. This treatise will become a standard work of reference, both in respect to its conclusions and to the statistical operations by which they have been attained.

F. G.

The Northern Barrier of India. A Popular Account of the Jummoo and Kashmir Territories. By Frederic Drew. With Map and Illustrations. (London: Stanford, 1877.)

THIS is a popular edition of Mr. Drew's valuable work on Jummoo and Kashmir, noticed in NATURE, vol. xii. p. 550. That work was perhaps too formidable for the general reader to undertake, and Mr. Drew has therefore done well in selecting from it those parts likely to be of general interest. The selection has been judiciously made, and as the illustrations have been retained, and a map showing the races as well as the physical features, the work will be found of great value and interest by those who hesitate to undertake the larger volume. It deserves a wide circulation.

The Two Americas: an Account of Sport and Travel. By Major Sir Rose Lambert Price, Bart. With Illustrations. (London: Sampson Low, 1877.)

WE took up this book with little expectation of finding much in it either edifying or interesting, and have been most agreeably disappointed. The author, in one of Her Majesty's ships, touched at various places on the east and west coasts of South America, and although most of the ground has already been gone over, he has the faculty of seeing and describing the already known under new aspects. He also visited Mexico, California, and the Yosemite region. From beginning to end the narrative is thoroughly entertaining, and even those who are well read in American travel will find that Sir Rose Price is able to tell them much that is new.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Nebulous Star in the Pleiades

A SHORT paragraph in a recent number of NATURE (vol. xv., p. 244) on the nebulous star in the Pleiades appears to call for a few remarks. With reference to the supposed difficulty of seeing with very large instruments a faint nebulosity in close proximity to a bright star, I may say, that the words of my assistant, quoted in the paragraph referred to, viz., "The Merope nebula *is never* perceived with Lord Rosse's telescopes," are perhaps a little too strong.

The entries relative to this object are five in number. In February, 1871, "Examined under very favourable circumstances; no nebulosity seen." August, 1872, "Examined Merope for Tempel's nebulæ; not a trace of nebulosity visible." (Both the above with the 3-foot reflector.) October, 1872, "Tempel's variable nebula not found; sky clear." September, 1873, "Nothing seen; much false light in field." December, 1875, "Examined Merope in consequence of M. Tempel's letter (*Ast. Nach.*, No. 2,045); no nebulosity seen; only same little false light as around the other bright stars; sky very misty."

It may be expected *à priori* that imperfections of a certain class, such as dust and other opaque substances, will interfere more with the action of a speculum than of an object-glass in searching for faint nebulosity near a bright star, inasmuch as in the former they will throw back and disperse over the field light which would otherwise have contributed to form the image of the star; whereas in the latter they will cause a general darkening by intercepting a certain percentage of light from stars and sky alike. It may therefore still be possible that under peculiarly favourable atmospheric conditions, and with a speculum just re-polished, we may still be able to detect the nebulosity, but it appears far more probable that we must look for an explanation of the difficulty of seeing the nebulosity to the comparative smallness of field of so large an instrument, which in general prevents the simultaneous comparison of the star under observation with neighbouring ones, and of a nebulous sky with an adjacent part free from nebulosity, so well as with a smaller telescope, and to the greater brilliancy of the image of the star while the nebulosity about it is only as bright as in the smaller telescope. From D'Arrest's remarks, quoted in NATURE, it appears that such objects are seen with much difficulty with a large refractor also. I have myself noticed, particularly in working with the six-foot reflector on the great nebula in Orion, that the fainter parts of the nebulosity, whether or not in the vicinity of bright stars, could best be seen with a finding eye-piece of 26′ field, of too low magnifying power to utilise more than two-thirds of the diameter of the speculum, and with my eighteen-inch Newtonian, the very faint nebulosity on the preceding side of the nebula could be much better traced.[1]

The absence of symmetry of the nebulosity round the star, as of that round ι Orionis, should, however, enable real nebulosity to be more easily distinguished from false light than in other cases. The more southern position of M. Tempel's observatory probably gave him some slight advantage.

It appears to be in the detection of minute stars and the examination of small details, where they exist, rather than in the search for faint diffused nebulosity, or nebulosity round stars that a large aperture gives so great an advantage. ROSSE

[1] P.S.—Although the faint diffused nebulosity preceding the nebula in Orion can in general scarcely be detected by any gradations of light within the limits of the field, the general luminosity of the field increasing up to the nebula is strikingly apparent in the six foot.

"The Movement of the Soil-cap"

UNDER the above heading Sir C. W. Thomson gives an interesting account of the "stone-rivers" of the Falkland Islands in a recent number of NATURE (vol. xv. p. 359), and attributes their origin to a general movement of the "soil-cap." Nothing can be clearer than his explanation of the mode in which the quartzites weather and break up on the hill-slopes, and one can quite understand how the resultant *débris* is gradually brought down into the valleys by the agents of change he refers to. But it is hard to see how these agents, after having got the *débris* down into the valleys, can subsequently spread it out into wide sheets, reaching "from a few yards to a mile or so in width," and resembling at a distance glaciers that seem as if descending from the adjacent ridges. The stones, as Mr. Darwin tells us, "are not thrown together into irregular piles, but are spread out into level sheets or great streams." Sir C. W. Thomson is apparently of opinion that these great streams of stones move *en masse* down the valleys, as "earth-glaciers," and he refers to the occurrence in Scotland of certain phenomena which seem to him to indicate similar movements of the "soil-cap." Geologists who have worked much in hilly countries, will readily recognise the truth of his descriptions—indeed the appearances to which he calls attention are quite common in such districts as the Northern Highlands and Southern Uplands of Scotland. The soil and rock-rubbish which are found resting upon our hill-slopes, and the bending-over of the truncated ends of the underlying vertical or highly-inclined strata are of course the results of atmospheric action. Rain or thawing snow filters into joints and crevices, and insinuates itself between bedding-planes, and frost tends to force these apart—the loosened rock moving in the line of least resistance, that is, *down hill.* At the same time both solid rock and detached fragments "weather," and thus grit and soil gradually form, while in like manner this gradually-forming "soil-cap" being itself acted upon by frost, is forced in the same way to move down the slope, a movement which is of course aided by a *vis a tergo*, the weight of the descending mass. Partly in this way, and partly by the direct action of rain, which not only washes the particles down, carrying away surface after surface, but sometimes soaks the loose "soil-cap" to such a degree as to cause the entire accumulation to "flow," whole hill-sides become swathed in mantles of soil and *débris*. But it is difficult to believe that an experienced observer would be puzzled to discriminate between such rubbish-heaps and true glacial moraines. Arrived at the foot of the slope, the rock-rubbish accumulates there, unless there be some stream at hand to denude it, and to sweep its materials, in the form of gravel, sand, and mud, down the valley. There are many good grounds, however, for believing that much of that "surface-wash" of soil and rock-rubbish which cloaks our hill-slopes to a depth sometimes of many feet, dates back to a time when our climate was considerably colder than it is at present, and that, while it was accumulating, local glaciers occupied many of our mountain-valleys. Putting aside "screes" and *débris*-slopes generally, I must say I have never seen any indication of that movement *en masse* of the soil-cap upon which Sir Wyville insists; and I hardly think many geologists will agree with him that it is "almost self-evident that wherever there is a slope, be it ever so gentle, the soil-cap must be in motion, be the motion ever so slow; and that it is dragging over the surface of the rock beneath the blocks and boulders which may be embedded in it," &c. Soil, as we all know, is always travelling from higher to lower levels, but this movement consists for the most part in the mere sweeping downwards of its component particles by rain and surface-drainage. It is true that the expansive power of frost, and the action of vegetation as described by Sir Wyville, may force a certain proportion of a soil-cap *en masse* down a gentle slope, but these influences will affect only an inconsiderable stratum; and, besides, the movement thus caused will be so trifling that the mere surface-action of rain would suffice to carry away the whole soil, particle by particle, long before the power of frost could have moved it bodily more than an inch or two. In reading the accounts of the wonderful "streams of stones" in the Falkland Islands, one is strongly reminded of the great moving masses of *débris* in certain valleys of the Rocky Mountains, as described by Dr. Hayden, and to surmise that the stone-rivers of the Falkland Islands may possibly be of the same nature. Dr. Hayden tells us that entire valleys are "covered thickly with earth, filled with more or less worn rocks of every size, from that of a pea to several feet in diameter. The snow melting upon the crests of the mountains, saturates these superficial earths with water, and they slowly move down the gulch much like a glacier. This is another process of grinding the underlying rocks, smoothing, and grooving them." But he apparently finds no difficulty in distinguishing between such "earth-glaciers," and the moraines left by those gigantic ice-rivers, which, according to him, flowed down the valleys of the Rocky Mountains during the glacial period. Suppose now that owing to some change of climate these earth-glaciers were no longer to be saturated with water to such an extent as to cause them to flow *en masse*, it is evident that the loose soil of which they are partly composed

would then be gradually removed by the action of rain and running water, while the angular blocks and *débris* would remain for a very much longer time, until eventually they crumbled down and were carried away in the form of gravel, sand, and mud. As far as one can judge from descriptions, the "stone-rivers" of the Falkland Islands seem to present very much the appearance which such dessicated earth-glaciers might be expected to assume, after their finer materials have been abstracted. The possibility that considerable masses of loose materials, such as a "soil-cap," may have moved *en masse*, has before now attracted the attention of some observers. Mr. Robert Mallet contributed a paper on the subject a number of years ago to the Journal of the Dublin Geological Society (see vol. v.); and in the *Jahrbuch der k.k. geologischen Reichsanstalt*, vol. xxii. p. 309, will be found an article by Theodor Fuchs, treating of the same subject.

JAMES GEIKIE

Geol. Survey, Perth, N.B.

Government Grants to Science

IN that part of the article in last week's NATURE on "Government Grants" which relates to the grant which has been for some years annually voted for pathological inquiries under the direction of Mr. Simon, a statement is made concerning myself, which I fear may convey a false impression as to the relation in which I stand to the Medical Department of the Privy Council.

Will you allow me to say that that relation is limited to the fact that the pathological investigations in question are conducted at the Brown Institution by my friend and colleague, Dr. Klein, who derives his commission directly from their lordships. I may take the opportunity of adding that the directors of the institution, of whom Mr. Simon is one, are as anxious as I am myself that its resources should be available, not only for this, but for all other purposes connected with the advancement of pathological science.

In former years, as your readers no doubt know, I have myself undertaken numerous investigations for the department, the last occasion occurring in 1875, but for some time past other and equally important duties have rendered this impossible.

March 5 J. BURDON-SANDERSON

Tints and Polarisation of Moonlight in Eclipse

THE gradation of the coloured tints on the moon's surface during total eclipse was seen here most clearly last Tuesday. At the middle of the eclipse the surface seemed to be obscured by a dusky disc surrounded by a broad bright copper-coloured rim, of uniform width, following the outline of the moon's edge. Just before totality ceased the surface presented the appearance of a series of coloured crescents having the centres of their boundaries on the line joining the point where ordinary light would soon appear to the moon's centre.

The order of colour was bright sea-green at the edge, followed by a pale golden tint, then copper tints, deepening to a dusky red or peach-bloom.

The explanation of these effects of sunlight in its passage through the earth's atmosphere will be found in Herschel's Astronomy, §§ 421-4.

The sky generally was free from any but very transparent clouds, and the air keen and frosty with steady breeze.

Shortly before the middle of totality I examined the light from the moon's surface by means of a double-image prism (made for solar eclipse work by Mr. Ladd) outside the eye-piece of a telescope with a $3\frac{3}{4}$ inch object-glass. On turning the prism round, with its front surface perpendicular to the axis of the telescope, the two images of the moon, in the parts where they did not overlap, appeared to brighten and darken alternately, interchanging intensities. The cycle was completed in course of revolution through 180°. This is conclusive as to the polarisation of the light received from the moon during total eclipse. I was unable to determine the character of the polarisation. There will be another total eclipse on August 23, for which I hope to be better prepared.

A. FREEMAN

St. John's College, Cambridge, March 1

The Patenas or Grass Lands of the Mountain Region of Ceylon

EVERYONE who has travelled through the Central Province of Ceylon must have been struck by the occurrence, apparently without sufficient cause, of tracts of grass-land varying from a few perches to hundreds, and sometimes thousands, of acres in extent, in the midst of otherwise interminable jungle. This land is exceedingly poor; almost without exception it is worthless to the coffee-planter for purposes of cultivation, and incapable of supporting any vegetation except its own acrid mànà grass (*Andropogon schœnanthus*) and a few stunted specimens of *Careya arborea* and *Emblica officinalis*. Yet on all sides of it will probably be found a rich forest vegetation that grows luxuriantly up to the very edge of the grass, where it terminates abruptly without any dwarfed or stunted undergrowth on the border-line to show that the soil gradually changes from a fertile to a sterile character. Sir Emerson Tennant, in seeking for an explanation of this curious phenomenon, appears to have been completely baffled, for he suggests nothing beyond what is contained in a quotation from Humboldt in reference to the grassy plains of South America, where that great traveller speaks of the destructive custom of setting fire to the woods when the natives want to convert the soil into pasture. One reason, which seems to be quite conclusive against this explanation being applied to the grass-lands of Ceylon, is that cleared forest-land, however neglected and impoverished, does not run into grass such as is found on these Patenas, but into a dwarfish jungle called "chena," and then again, after a considerable period of time, into forest. Besides, it very frequently happens that these grass-lands are the very last pieces of ground that one would expect the natives to select out of the forest to bestow labour on in clearing and burning. Another and minor argument against this view is that the natives, whose traditions extend back for a considerable period of time, can give no account of the origin of Patena-lands, as no doubt they would be able to do if their ancestors and themselves were the cause of their existence. Other causes, therefore, than that of human agency must be sought for. One of these I believe I discovered during my residence in Ceylon, and I should be glad to learn whether any of the readers of NATURE have noticed the same in any part of the gneiss formation of Southern India, or indeed in any extensive gneiss formation within or without the Tropics. How far this particular cause operates in other instances than the one presently to be mentioned I am unable to say, but I am inclined to the belief that although it does not hold universally, it nevertheless holds pretty generally in the case of the larger patenas. It must be remembered that the mountain region of Ceylon is entirely a gneiss formation, very much dislocated during upheaval, and consisting at the present time of exceedingly deep valleys and precipitous mountain ranges. In this gneissic series occurs a band of half-formed quartzite several hundreds of feet in thickness, to which my attention was first attracted by noticing that below it, *i.e.*, where its *débris* accumulated, nothing but patena was to be found, whilst above, where the ordinary gneiss rocks were in a state of disintegration, the jungle and coffee was of a most luxuriant character. This band of quartzite stands out from the ordinary gneiss cliffs in the valley leading from Pussellawa to Ramboda, about twenty miles south of Kandy. It extends for about five miles in the form of a cliff, broken through here and there by ravines. Its upper surface, beginning at an elevation of 4,500 feet on the Helbodde coffee estate, dips under the main waterfall at Ramboda, and disappears under the ordinary gneiss at an elevation of about 3,000 feet above sea-level. This rock weathers very black, and is distinguishable at a distance of several miles from the ordinary gneiss above it and in its neighbourhood. It seems to disintegrate into little else than a quartz sand impregnated with iron and entirely incapable of supporting the usual forest vegetation with which the district, except in this particular spot, abounds. I have been informed that in the extensive patena district of Ouvah, which, roughly speaking, is a plain almost surrounded by mountains, a few miles south of the district just mentioned, and separated from it by the loftiest mass of mountains in the island, the same quartzite formation occurs, but not having had an opportunity of visiting and examining it, I am unable to say how far this information is to be relied on. When one remembers how very extensively the gneiss is broken up throughout the whole of this mountain region of the Kandyan province, it seems not improbable that other patenas, especially the larger ones, owe their origin to the cropping out of this quartzite band, although it is difficult, probably impossible in many cases, to determine that such is the case.

R. ABBAY

Oxford

The Estimation of Urea by means of Hypobromite

ALLOW me to correct a slight mistake into which your reporter has fallen, no doubt inadvertently.

Knop was the first to propose (in 1870) the use of a strongly alkaline solution of hypobromite for the estimation of urea in place of the hypochlorite previously employed by Davy. Every chemist who since 1870 has worked with the process has, as far as I am aware, retained the exact composition of Knop's hypobromite solution.

The modifications in details which I have proposed are therefore for the purpose of facilitating the working of Knop's process. This process is, I believe, the one best suited for general use. Certainly no other process as yet devised equals it in rapidity and ease of working, and few, if any, surpass it in accuracy. If, then, it should be deemed desirable to attach any names to this process, I would suggest that it be called the Knop-Davy process. A. DUPRÉ

Westminster Hospital, February 24

Colœnis Julia in Texas.—Venomous Snakes devouring each other

IN Chapter xv. of his "Geographical Distribution of Animals," Mr. Wallace mentions *Colœnis* (belonging to the Nymphalidæ) as one of the South American forms, which do not pass north of Costa Rica or Nicaragua. I have taken, though only once during nine years, a female of *Colœnis julia*, Hübner, here at Bastrop, on the Colorado, in about 30° N. latitude, but I believe this to be the first time where said species has been captured in temperate America.

I do not know whether the fact has been observed before, that one venomous snake will devour another belonging to even the same genus. Some time ago I captured, on the Guadaloupe River, a large and very thick *Ancistrodon pugnax* (Water Moccasin), one of the Crotalidæ, and upon opening it, found inside a large and quite well preserved specimen of *Ancistrodon contortrix* (Copperhead).

Although I have examined many venomous snakes since, I never found a similar case, and the stomachs contained only mice, frogs, &c. L. HEILIGBRODT

Bastrop, Texas, February 7

Lowest Temperature

THE temperature experienced during the night between February 28 and March 1 was so exceptional, that it may be thought worthy of a passing remark. The minimum reading at this observatory was 9·1° F., which is the lowest recorded during the last sixteen years; that of December 24, 1860, was, however, lower, being 6·7°. The lowest readings for February and March during the past twenty-eight years were respectively 10·1° on February 1, 1855, and 14·5° on March 4, 1866.

Stonyhurst Observatory, March 2 S. J. PERRY

Meteor

I SAW the meteor described by Mr. Ingleby on February 26, about 6.20 P.M., Greenwich, from the railway platform at Gloucester. It was moving very slowly from right to left parallel with the horizon to the right of the moon, and a good deal below her; I should think two or three degrees at least. A bright track was left behind. The size must have been considerable for it was a very brilliant evening, and still almost daylight. No stars were visible in that part of the sky. I could not then see the position of Sirius, however. It was tolerably bright twenty minutes later. Gloucester is nearly due west of Ilford, and about 100 miles distant in a straight line.

Westbury-on-Severn, March 3 ALBERT J. MOTT

REPORT ON THE GOVERNMENT METEOROLOGICAL GRANT

THE following is the Report to the Lords Commissioners of her Majesty's Treasury by the Committee appointed in November, 1875, to inquire into the conditions and mode of administration of the annual grant of 10,000*l*. in aid of meteorological observations. That Committee consisted of the following:—Sir W. Stirling Maxwell, Chairman, Mr. T. Brassey, Mr. T. H. Farrer, Mr. Francis Galton, Mr. David Milne Home, Dr. J. D. Hooker, Mr. R. R. W. Lingen, C.B., and Lieut.-Gen. Rd. Strachey. We hope to make a few comments on the Report in our next number.

1. We have, in accordance with the Treasury Minute of November 2, 1875, made the inquiries therein mentioned. In doing so we have asked for the opinion of the President and Council of the Royal Society, who have favoured us with an elaborate report. We have also taken evidence from members and officers of the Committee which has hitherto administered the grant; and from many other persons whose opinions appeared to us to be important, either on account of their scientific eminence, their official position, or their practical knowledge and experience of the subjects in respect of which, and the classes to whom, meteorological knowledge is specially useful. To this report and evidence, which are contained in the Appendix to our Report, we desire to refer in support of the following conclusions:—

2. The business of the Committee may be considered under two heads, viz.:—

(1) The Meteorology of the Ocean.
(2) The Meteorology of the British Isles.

And the business relating to the latter of these may again be subdivided as follows, viz.:—

(*a*) That branch which by the use of the telegraph collects material for, and issues daily weather charts and storm warnings.

(*b*) That branch which collects, digests, and publishes meteorological statistics. This last branch depends on two sources of information; viz. (1) on observations taken at a limited number of stations which are provided with self-recording instruments, and which furnish continuous observations; and (2) on observations taken by the eye at stated daily periods at more numerous intermediate stations.

3. All these divisions and sub-divisions of the business have produced results of value, and should be continued. For more specific information on these points we beg to refer to the evidence, and especially to the report of the President and Council of the Royal Society.

4. Ocean meteorology should, we think, be transferred to the Hydrographical Department of the Admiralty. The reasons for this are, first, that whilst this department is equally able with the present Committee to collect observations from merchant ships, it must be better able to collect similar observations from her Majesty's ships; and, secondly, that from its experience in chartography and in nautical wants, it is specially competent to put the results in a form useful to navigators.

5. In performing this new duty the Hydrographical Department should be in such relation with the office or department which manages land meteorology, as to insure that the observations taken at sea will be so made and digested as to be available for scientific purposes in connection with those made on land.

6. Every effort should be made to act in concert with other nations in ocean meteorology, so that labour may be economised, and the utmost possible use be made of all available materials.

7. In recommending the above transfer we assume that the Lords of the Admiralty will be willing that the Hydrographical Department should undertake the duty; that that department will be organised and made in all respects adequate for the purpose; that the observations from merchant ships which have been hitherto successfully collected by the present Committee, and which are necessarily more numerous and more varied than any which can be obtained from the Royal Navy, will continue to be collected; and that the advancement of science, so far as the ocean is concerned, will be no less an object with the Hydrographical Department of the Admiralty than it has hitherto been with the present Committee.

8. As to land meteorology we have considered the alternative proposals of appointing one permanent head, as was the case before 1866, and of leaving matters to be managed by a Committee in the same manner in which they have since been managed. But we cannot recommend either of these proposals. As regards the first, although it may be desirable at some future time to create a permanant meteorological establishment on some such footing as that of the Astronomical Observatory at Greenwich, with an officer of scientific eminence at its head, we think that matters are scarcely ripe for such a step at present. As regards the second, it cannot be expected that the gentlemen who now constitute the Meteorological Committee, and who have by way of experiment given much valuable time to the work in its

initial stages, will continue to do so under the existing conditions.

9. We think, however, that the Royal Society should be invited to continue to recommend to the Government persons eminent in science to superintend the work, under the title of a Meteorological Council. They should be appointed for limited periods and should be eligible for re-appointment. They should be fewer in number than the present Committee, and the means should be provided of remunerating them in the shape of fees for attendance. They should have and exercise complete control and supervision over and be responsible for the business, expenditure, and staff, the chief officer of which would be more appropriately designated by the title of secretary than by his present title of director. The important duty of selecting a chairman, would rest with the Royal Society or with the members of the Council.

10. The present system of collecting daily information by telegraph and of issuing storm-warnings should continue. There is evidence that it is of real value to the seafaring population, and that it leads them to thought and observation on the subject of weather. The want of communication by telegraph on Sundays causes a serious defect in the system, which ought to be remedied.

11. An endeavour should be made to put into clear shape, and to issue, for public information, the maxims or principles upon which storm-warnings are in future to be given. This information should be revised from time to time so as to embody the latest results of experience.

12. The process of issuing daily weather-charts, with explanations, should continue, with such improvements as experience may from time to time suggest. The information thus given not only creates a general interest in the subject, but is of value to persons who are disposed to engage in the discussion of scientific meteorological problems.

13. A certain number of continuously self-recording stations should be retained. But it may deserve consideration by the Council whether some at any rate of the existing stations may not be discontinued, and others obtained on more eligible sites. Doubts have also been expressed whether in the present state of meteorological science the minute exactness of the observations now taken at these stations is of sufficient comparative value to justify the whole of the costs which they involve, when there are so many other objects of meteorological inquiry which call for increased expenditure.

14. The present system of supplementing self-recording observations by returns from eye-observers at intermediate stations should be continued. The positions of these latter stations should, however, be revised, and their number increased, especially in Ireland (where at present there are but few of them); so that the returns may exhibit a fair representation of the different climates and weather of the British Isles. Every possible endeavour should be made to secure the co-operation and assist the efforts of the different societies or other local bodies engaged in meteorology, and to further the adoption of uniform methods.

15. The evidence of the Astronomer-Royal and of other scientific witnesses contains some important observations on the form and extent in and to which the results of the observations should be published. This is a subject which deserves the careful attention of the Council with a view to saving all unnecessary expense on the one hand, and on the other to publishing the results in such a form as may render them most available for use by men of science.

16. There is evidence to show that the system adopted in the United States by which observations are taken over the large area of the North American continent and are communicated by telegraph to Washington, is of great value both for the immediate practical purposes of agriculture and navigation, and also as throwing light on the general movement of the atmosphere. The position and extent of the United Kingdom do not admit of any similar system of equal value. But it is desirable in the general interests of science as well as for practical purposes, that by means of co-operation between the different European nations synchronous observations should be made throughout Europe and the adjacent seas, so as to afford all possible facilities for synoptic charts of the weather in Europe. To this end this country should give all the help it can.

17. There is important evidence that the science of meteorology at the present moment stands in need of hypothesis and discussion at least as much as, if not more than, of observation. It is not easy to lay down any rule concerning the method by which such investigations may be promoted. But we think that the Council should be at liberty to appropriate a part of their annual grant to the purposes of any special researches which they may think important, and in such cases it should rest with them to select the investigators, and fix the remuneration.

18. There is evidence of a connection between weather and health; but it does not appear that any special meteorological observations are wanted at present, or are likely to be wanted in future for this special purpose, other than the observations, which, under the scheme we have recommended, the Council should collect for general purposes.

19. Again, the importance of meteorological data to the agriculturist and dealer in agricultural produce is clearly established. But neither do their requirements demand other observations than should be included in the general returns and information obtained by the Meteorological Council.

20. As regards the forms in which the information thus collected can be made most available for sanitary and agricultural purposes, it appears desirable that the Meteorological Council should place themselves from time to time in communication with the Registrars General, and with such bodies as the Medical Council, and the Agricultural Societies of the United Kingdom.

21. The expense of the scheme we have suggested may be estimated as follows:—

The following return has been prepared by members of our Committee who are also members of the Meteorological Committee of the approximate present cost of the Meteorological Office:—

	£
Director's office and general control	2,500
Ocean meteorology, excluding supply of instruments	1,500
Land meteorology including self-recording observations and supply of instruments	3,500
Telegraphy and storm-warnings	2,500
Total	£10,000

The modifications that have been proposed would lead to certain additions to the necessary outlay, among which may be specified—

	£
Remuneration of Council, say	1,000
Special scientific researches	1,000
Extension of telegraphy on Sundays	500
New land stations	1,500
Inspection of stations	500
Total	£4,500
Deduct for ocean meteorology transferred to Admiralty	1,500
Net increase	£3,000

This sum being added to the present grant of 10,000*l.* would bring the whole sum to be placed at the disposal of the Council up to 13,000*l.* yearly. Assuming the expense of ocean meteorology transferred to the Admiralty to remain under the new arrangement at its old figure, 1,500,[1] the whole additional annual burden on the National Exchequer proposed in the above suggestions is 4,500*l.* or 14,500*l.*, instead of the existing grant of 10,000*l.*

22. With reference to the Scottish Meteorological Society, the representations of which have been specially referred for our consideration, we desire to offer the following remarks:—

It seems essential that any grant of public money for the purposes that have been indicated in our recommendations, should be applied under the immediate responsibility of the Council, and that no expenditure should be incurred which those purposes do not absolutely require. There is evidence to show that a large and trustworthy amount of co-operation may be obtained in all parts of the United Kingdom, from observers who do not require remuneration for their service, and it seems very important that such co-operation should be fostered to the utmost. Any system of payment for meteorological registers which was not very strictly limited, would necessarily involve the concession of payments to all observers, and might entail a very large outlay which has hitherto been avoided, and which there is reason to believe is not at present really called for.

We are of opinion, therefore, that only such payments should be made from the grant placed at the disposal of the Meteoro-

[1] See paragraph 25 of this Report.

logical Council to the Scottish Meteorological Society, as are necessary for obtaining observations at stations required for the purposes of the Council; for securing the proper inspection of stations the registers from which are required for the general purposes of the Council; for the needful compilation and check of such registers; and for meeting other charges directly arising from these services; or for special researches conducted by the Society with the approval of the Council; but that no grants should be made to ordinary observers, nor for any general purposes of the society which lie beyond the scope of the operations to be placed under the Council.

23. We think that the same principle should be applied to all similar local bodies interested in the study of Meteorology; so that, in fact, no payments should be made to them except for results sought for by the Council.

24. We have indicated above in very general terms the functions of the proposed Council, and we do not think it desirable to fetter their discretion by further details. We append, however, to this report a paper by a member of the present Committee of the Royal Society, who is also a member of our Committee, stating what, according to present experience, are, in his opinion, likely to be their duties.

25. The later stages of the inquiry in relation to the transfer of oceanic meteorology to the Admiralty have raised some serious questions of expense, which the Government will, doubtless, require time to consider. We think it only just to the Committee which has heretofore had the administration of the annual grant to report our opinion that very good and valuable work is being done by it, and that if funds were provided to admit of the more responsible and more extended action of the Council, as suggested in paragraphs 9 and 22 of our Report, and if, at least provisionally, some assistance were given to the Scotch Meteorological Society, the more immediate objects referred to our Committee would be met, and there need be no interruption of the Committee's operations pending the delay, if any, which may occur, whilst the feasibility of transferring oceanic meteorology to the Admiralty is being maturely considered by her Majesty's Government.

It is important in connection with this part of the subject to bear in mind the strong claims which the Superintendent and other members of the existing staff have to continued employment.

26. In recommending the above changes we feel bound to express our sense of the great value of the disinterested services which, at the cost of much time and labour have been rendered during so many years by the Committee appointed by the Royal Society.

27. We are aware that what we are proposing is still tentative only, and we recommend, in conclusion, that there shall be a further inquiry and report at the end of (say) five years.

RESEARCHES ON THE SPECTRA OF METALLOIDS[1]

THIS paper was published by Mr. Thalen after Mr. Angström's death. Mr. Thalen states, in the introduction, that only the first sheet was printed during Mr. Angström's life, who in the remainder would have liked to alter some passages and add others. Yet we take it that such alterations only would have referred to matters of detail, and that as far as the general conclusions are concerned the paper represents fairly Mr. Angström's opinion on the important questions discussed therein. Mr. Thalen has made the measurements, while the experiments were made by him in conjunction with Mr. Angström.

After a few historical remarks the authors give the following judgment on the question of double spectra :—

"We are far from denying that the lines of an incandescent gas may come out in greater number as the temperature, or perhaps only the quantity of radiating matter increases, or that some rays may increase much quicker than others in intensity. But it is certain that the assertion of various physicists that the lines originally seen may disappear altogether, and that in this way the spectrum may change completely in appearance is as unlikely from a theoretical point of view as it is contrary to experience. If such properties were real all spectroscopic researches would be rendered impossible as each element could play as far as its spectrum is concerned the parts of a Proteus.

"We do not deny that an elementary body may in certain cases give different spectra. The absorption spectrum of iodine, for instance, is quite different from its emission spectrum obtained by means of the electric spark. All bodies existing in different allotropic states will give different spectra corresponding to these different allotropic states provided that the allotropic states still exist at the temperature of incandescence.

. . . .

"Oxygen, for instance, would present two different absorption spectra, one belonging to oxygen the other to ozone. But as ozone is destroyed at a high temperature, only one spectrum of incandescent oxygen can exist.

"Sulphur in the solid state exists in different allotropic states, and some observations lead us to believe that even as a gas it may exist in different states. Supposing this to be true, sulphur will give us several absorption spectra, while the possibility of a single or several emission spectra depends on the question whether the more complicated allotropic states support the temperature of incandescence.

"It is evident that the above cases do not form an exception to the general law which we have given, that an elementary body can only give one spectrum. In fact, if we suppose that the allotropic state is due to molecular constitution, it will possess from a spectroscopic point of view, all properties of a compound body, and in consequence it will be decomposed in the same manner by the disruptive discharge of electricity."

The paper then goes on to discuss the difference which is noticed in the electric spark, between the aureole and the spark itself. Messrs. Angström and Thalen sum up what they have said on the subject in the following words :—

1. There are two kinds of electric discharge, one of tension, which takes place by explosion, or disruptively, the other of quantity, which takes place by conduction, or continuously.

2. By the disruptive discharge which always takes place when the tension is sufficiently great, the body is, as a rule, torn into its smallest particles, and thus decomposed into its elements if the body is compound. The phenomenon of incandescence which accompanies both the mechanical disruption and chemical decomposition, cannot be considered as a consequence of the augmentation of temperature, but we ought rather to say that the high temperature is an effect of the mechanical and chemical force which disintegrated the body. In addition to the decomposition produced directly by the disruptive discharge, we may have chemical actions, which are, however, of a secondary nature.

3. When the electricity is conducted by conduction we must distinguish between two actions. We have actions which are entirely due to heat, and which belong to the conductors themselves. They increase with the square of the intensity of the current. We have, secondly, actions which make themselves perceptible at the surface of bodies, and which are proportional to the intensity of the current. These latter actions are confined in elementary bodies to a variation in temperature, but if the body is compound they may consist in chemical effects, which we call electrolytic actions. These two phenomena, the Peltier effect and the phenomenon of electrolysis, must be considered as different manifestations of the same force; one or other of the actions takes place according as the body is simple or compound.

These laws, which are demonstrated to hold for solid and liquid bodies, must also be applied to gaseous bodies, where we must therefore expect electrolytic actions as well as chemical ones of a secondary nature.

Our authors then go on to discuss the spectra of carbon and their compounds. They begin again with a historical statement of the work done in this respect, and as this part of the paper does not contain anything new to those who are interested in the matter we pass to the question which they propose to solve: "How are we to explain all these different spectra of carbon compounds?" They draw attention to the fact that all these spectra have a common characteristic, as they consist of bands which can be resolved into fine lines. There is, however, one spectrum which must be attributed to carbon, while the authors attribute all other spectra to carbon compounds. This spectrum is a line spectrum. It is obtained from carbon poles by means of a powerful jar.[1]

If we allow a spark to pass between carbon electrodes, the lines are not seen in the middle of the field, but only close to the poles similar to the metallic lines. If the discharge pass through some carbon compound, one obtains not only these carbon lines, but also those of oxygen, hydrogen, or nitrogen, that

[1] Abstract from a paper in the "Nova Acta Regiæ Societatis Scientiarum Upsaliensis," vol. ix., 1875, by A. J. Angström and T. R. Thalen.

[1] It is the spectrum marked by Watts No. IV.—A. S.

is, all lines belonging to the elements entering into the carbon compound.

Round the electrodes of carbon we observe during the disruptive discharge an aureole, which indicates a continuous discharge. The spectrum of the aureole depends on the nature of the medium in which the discharge passes; in nitrogen we find the blue and violet groups which characterise cyanogen; in hydrogen it is the spectrum of the hydrocarbons[1] which we observe; in oxygen we get the spectrum which a Geissler tube, filled with carbonic oxide, shows.

The shaded bands of cyanogen which are situated in the blue and violet part of the spectrum, are also seen if the spark passes the luminous part of a gas flame, or in the voltaic arc between the carbon electrodes of a powerful battery. In the spectrum of the voltaic arc, however, the brilliant lines of cyanogen are mixed with those of hydrocarbons, the splendour of which is still more magnificent.

After these observations we may consider it to be a demonstrated fact that the aureole gives respectively the spectra of cyanogen, hydrocarbon, oxide of carbon, or carbonic acid, according as the gas which surrounds the electrodes consists of nitrogen, hydrogen, or oxygen. The most natural supposition is, therefore, that the spectra belong really to the compound bodies, which is the more probable as the general appearance of these spectra suggests at once an origin of compound bodies rather than of elementary bodies.

It is well known that carbonic acid is decomposed by the electric current, and that the spectrum which is observed belongs exclusively to carbonic oxide, which is formed. One might therefore imagine that carbonic acid would not have any spectrum of its own. If, however, carbonic acid is formed, as, for instance, while cyanogen burns, it appears probable that lines belonging to carbonic acid can appear, and this opinion has been confirmed by an observation of Plücker. He has found that the shaded red bands of cyanogen burning in air or in oxygen become stronger and wider as the combustion becomes stronger. An experiment made by us with a spark passing in cyanogen gas, circulating in a glass tube and freed therefrom by degrees of every trace of oxygen, has taught us that these red bands only extended to the first band of hydrocarbon, and even vanished during some instants of the experiment. The probable cause of the appearance of the spectrum of hydrocarbon in this case must be looked for in the impossibility of drying the gas completely, if it is prepared with cyanide of mercury.

It seems to us that it is much more difficult to explain the appearance of the spectrum of hydrocarbons in the combustion of any compound of carbon and hydrogen, and also, according to Mr. Attfield, in the flame of carbon disulphide. Though this spectrum was considered by some observers to be due to carbon, we cannot accept this view, and for this reason: If we employ a condensator the spectrum of coal gas shows not only the spectrum in question, but also the lines of carbon and hydrogen. The appearance of the shaded bands, being similar to those of cyanogen, shows at once, as we have repeatedly said, that the body is compound.

The difficulty, it seems to us, must in great part disappear if we could show that the same chemical compound is always formed in the combustion of any hydrocarbon. M. Berthelot has shown this to be true. According to him acetylene is formed whenever an incomplete combustion of any hydrocarbon, ether, &c., takes place, and even if the electric spark passes between carbon electrodes in hydrogen gas. It is therefore very probable that the spectrum which is formed for all carbon compounds is due to acetylene.

As far as the observation of Mr. Attfield is concerned, that oxide of carbon gives the ordinary spectrum of the hydrocarbons, we must observe that this does not agree with our own experiments. In a Geissler's tube, containing carbonic acid or carbonic oxide, one can certainly find traces of the spectrum of hydrocarbon, as the gas is never altogether dry, but according to Plücker's observation, the particular spectrum of oxide of carbon has no resemblance to it.

To the left of the Fraunhofer line G one sees generally a very strong line which really belongs to carbon. We find here the same thing which we have mentioned speaking of the spectra of the metallic oxides, that often the spectrum of the oxide is mixed with some of the lines of the elementary body.

As a second example Messrs. Angström and Thalen take the spectrum of nitrogen. The so-called line spectrum of nitrogen was first observed by Angström, while v. d. Willigen observed a different spectrum seen in the aureola when the discharge takes place in air. The two spectra which Plücker observed were therefore not new, though he gave a new way of obtaining them. The following is a translation of the author's remarks on the origin of the two spectra:—

As to the interpretation of these two spectra we think that they only depend on the way in which the electric discharge takes place, and belong to two different bodies. The spectrum of lines caused by the disruptive discharge must be attributed to nitrogen as it appears in Geissler's tubes under the same circumstances which accompany the disruptive discharge, but the shaded bands belong doubtless to some combination of nitrogen formed by the discharge of quantity or by conduction.

. . . .

In the aureole at the positive pole we find a great number of shaded bands in which we distinguish two different series, one situated in the least refrangible part of the spectrum, and another in the green, blue, and violet parts. The appearance of these two series is different and gives rise to the suspicion that they belong to two different bodies. Whether this be true or not it is certain that their intensity varies much according to circumstances and in different ways.

At the negative pole we observe a bluish violet sheet the spectrum of which, situated in the green, blue, and violet, does not change with the nature of the electrodes.

In Geissler's tubes, containing rarefied nitrogen, we find for the continuous discharge the same spectra as in the aureoles in the atmosphere. But the positive light, which is very intense, is not only seen near the pole but also in the capillary parts of the tube. At the negative pole the bluish violet sheet gets larger and more brilliant as the exhaustion proceeds.

We now ask which combinations of nitrogen can cause the spectra of the continuous discharge? As far as the negative light is concerned we are in complete ignorance on the subject. As to the gas which is found at the positive pole one can prove by means of a solution of sulphate of iron that nitrogen dioxide is formed. It is well known that the electric spark passing through air produces the red fumes which indicate the existence of nitrous acid. It follows that nitrogen combines under these circumstances with oxygen. The only question therefore is, where does the oxygen come from in a tube filled with nitrogen? We must remember that in making nitrogen we can never entirely get rid of air, or at least there will always be a trace of aqueous vapour present, as is shown by the hydrogen line C. This fact sufficiently explains the possibility of the presence of a compound of nitrogen and oxygen. As the luminous spectrum bears no resemblance to the absorption spectrum of nitrous acid fumes, we conclude that the dioxide of nitrogen causes the shaded bands at the positive pole or in the aureole, and in the capillary part of Geissler's tube containing nitrogen. Several experiments are mentioned which have been made by the authors. Those on the spectrum of carbon run as follows:—

1. Spark between carbon electrodes in oxygen with condensator. The lines of oxygen and carbon are seen.

2. Spark between platinum electrodes, 35 mm., apart in a current of carbonic acid. Two jars used as condenser. The revolving mirror showed that the spark was instantaneous. The lines of platinum, carbon, and oxygen, were seen.

3. Same as 2. Distance of electrodes 5 mm. The aureole gave the spectrum of carbonic acid.

4. Spark between aluminium electrodes 10 mm. apart, in a current of coal gas. The lines of hydrogen, carbon, and the bands of carburetted hydrogen are seen.

5. Spark without condenser in a current of cyanogen. The lines of hydrogen, nitrogen were seen, besides the bands of carburetted hydrogen, and some bands of cyanogen.

The experiments on the spectrum of nitrogen have been made with atmospheric air. A solution of sulphate iron was used to show the presence of dioxide of nitrogen. The appearance of Geissler's tubes at various pressures are given.

Exact measurements of all the spectra discussed in the paper are given, not only for the more intense lines or bands, but exact micrometer measurements of some of the band. The names of the authors are a sufficient guarantee of the accuracy of these measurements. Excellent plates with drawings of the spectra are added. A copy of the measurements will be found in the first number of the *Beiblätter zu Poggendorff's Annalen*.

ARTHUR SCHUSTER

[1] Messrs. Angström and Thalen call Swan's spectrum of the candle the spectrum of hydrocarbons.

SIR WILLIAM THOMSON ON NAVIGATION[1]

POPULAR lectures rarely contain much that deserves repetition or notice in a review. But when the lecturer is Sir William Thomson and his subject navigation, we may be sure that we shall hear something that we have not heard before, and that we should hear, if we wish to keep abreast of the advance of nautical science. When a reformer contents himself with merely making suggestions and leaving it to others to test them, his work is comparatively easy and its results are proportionally valueless. The suggestions of Sir W. Thomson have the very special merit that they are submitted to a practical test before he gives them utterance, and after he has done so he is far from considering his connection with them over. Every part of every crude idea or novel appliance is submitted to a searching process of natural selection which must cost the author as much labour as to watch it gives the onlooker pleasure, and those who see only the final survival of the fittest cannot form anything like a just conception of the time and pains which have been bestowed on the rejection of the less fit.

We cannot here find space to notice those parts of the lecture which are the reproduction of old and received truths, interesting though these are by virtue of their skilful dressing. We must pass on at once to mention one or two points which are either in themselves new, or which have as yet failed to secure the recognition they deserve.

The first important novelty we come to is the discovery by Mr. Hartnup, astronomer to the Harbour Board of Liverpool, of a system of rating chronometers, which gives an almost perfect means of compensating for change of rate due to change of temperature. It had long been known that no compensation balance could be made to keep time correctly through wide ranges of temperature :—

"Thus the best chronometers of the best makers in modern times are practically perfect only within a range of 5° or 10° Fahrenheit on each side of a certain temperature, infinitely near to which the compensation is perfect in the individual chronometer.

"The temperature for which the compensation is perfect, and the amount of deviation from perfection at temperatures differing from it are different in different chronometers. Mr. Hartnup finds that at the temperature for which the compensation is perfect, the chronometer goes faster than at any other temperature, and that the rate at any other temperature is calculated with marvellous accuracy (if the chronometer be a good one) by subtracting from the rate at that critical temperature the number obtained by multiplying the square of the difference of temperature by a certain constant coefficient."

Two chronometers recently carried from Liverpool to Calcutta, when rated on Mr. Hartnup's plan, gave a mean error of six seconds, while by the ordinary method the reckonings of Greenwich time from them differed by 4 minutes 35 seconds. The navigator could easily secure the advantages of Mr. Hartnup's system by noticing the temperature of his chronometer-case daily, and entering a few figures in a note-book. His work would be much facilitated if the thermometer used were graduated to squares of numbers of degrees from the temperature of maximum rate.

The lecturer discusses at considerable length various modifications of the pressure-log, the invention of Mr. J. R. Napier and Mr. Berthon, the principle of which is to measure the speed of the ship by observing to what height a column of water rises in a vertical tube, the bottom end of which dips into the sea and faces forwards. It shows the ship's velocity through the water at any instant, instead, like all other logs, of telling the distance run during a known length of time. The latter piece of information is what is chiefly wanted for the purposes of ordinary navigation, but the former could not fail to be of immense use in the navy when ships are sailing in squadron. Even now, a rough approximation to a knowledge of velocity is got in the navy by the use of indicators showing the number of revolutions per minute made by the screw, and these satisfy very imperfectly the requirements of the case, as appears from the evidence given at the court martial on the loss of the *Vanguard*. The Admiral signalled to the squadron that his ship was about to go at thirty-three revolutions, which he afterwards explained to mean that he desired the squadron to go as nearly as possible at a speed of seven knots. Had each of the ships been provided with a pressure log, he might at once have given an order of whose meaning there could have been no possible doubt, and which it would have been perfectly easy for every ship to obey.

The taking of soundings to determine the depth is one of the most important of nautical operations. In surveys of the ocean's bed and for guidance in cable laying, soundings have to be made in great depths, often of several thousand fathoms. The trouble and time involved in taking a deep-sea sounding have been greatly reduced by Sir W. Thomson by the substitution of a single steel pianoforte wire for the hemp rope formerly used as a sounding line. The advantage of the wire is the comparatively small resistance it meets with in passing through the water. When hemp rope is used for sounding in deep water a weight of three or four hundred pounds must be attached to it, and even then it descends very slowly. When it reaches the bottom the weight is detached by a trigger and is therefore lost. When wire is used a weight of about thirty pounds suffices; it descends very much more rapidly, and there is nothing to prevent its recovery each time. For very small depths such as are met with in the immediate neighbourhood of land, the hand lead is convenient and sufficient, but there is a third class of soundings, those which are (or should be) made in depths of about twenty fathoms and upwards when a ship is approaching land. To be able to take "flying" soundings—that is, to find the depth without stopping the ship—in any depth from 20 to 150 fathoms, is a matter of the greatest possible importance in ordinary navigation. Sir W. Thomson has succeeded in making it easy to do this, by the aid of his pianoforte wire in combination with another apparatus which he described at the recent meeting of the British Association. This consists of a pressure gauge of very simple construction, which is attached close to the end of the sounding-line, and which, by registering the maximum pressure to which it has been subjected during immersion, registers the maximum depth it has attained. This indication is of course quite independent of the length of wire out, and is not affected by the fact that the ship is in motion. The pressure gauge consists of a small glass tube, of about $\frac{1}{10}$ inch bore, open at the lower end, but closed at the top. As this descends, the water rises in the tube compressing the column of air. In order that a permanent record may be left of the maximum height to which the water rises, the interior of the tube is coated along its whole length with starch, in which red prussiate of potash has been dissolved, and just at the mouth of the tube are placed a few crystals of sulphate of iron, which are held in position by an outer guard tube. The water which rises in the tube carries with it a little sulphate of iron in solution, and so leaves a permanent record of its height by staining the tube with Prussian blue. The system of sounding by wire has now had abundant trial, and its success is thoroughly established. Its author was, no doubt, quite within the

[1] Navigation. A Lecture delivered under the auspices of the Glasgow Science Lectures Association. By Sir William Thomson, D.C.L., LL.D., F.R.S., Professor of Natural Philosophy in the University of Glasgow, and Fellow of St. Peter's College, Cambridge. (London and Glasgow; William Collins, Sons, and Company, 1876.)

limits of safe prophecy when he declared to the British Association in Glasgow that the old system of deep-sea sounding by hemp rope had done its last work on board the *Challenger*.

In proceeding to speak of astronomical navigation the author begins by giving a series of definitions which differ from those commonly given, by being based on no assumption as to the figure of the earth, so that they "designate in each case the thing found when the element in question is determined by actual observation." Thus the latitude of a place is defined as the altitude there of the celestial pole. After a flying shot at the British Statute mile, whose existence "is an evil of not inconsiderable moment to the British nation," he goes on to describe the various means of deducing a ship's place from observations of the heavenly bodies, giving the place of honour to Sumner's method, of the merits of which we had recent occasion to speak (NATURE, vol. xiv. p. 346).

To communicate information from ship to ship by signals is an object of first importance to the sailor. By day, in clear weather and with skilful men, the system of flag and semaphore signals at present in use in the navy is very complete and effective. By night, in clear weather, Capt. Colomb's method of flashing signals has been successfully used in the British navy for nearly twenty years, but its adoption has not been nearly so general as properly to meet the requirements of the case. On this point Sir W. Thomson says:—

"The essential characteristic of Capt. Colomb's method, on which its great success has depended, consists in the adoption of the Morse system of telegraphing by rapid succession of shorts and longs, 'dots' and 'dashes,' as they are called; and, I believe, its success would have been still greater, certainly its practice would have been by the present time much more familiar to every officer and man in the service than it is now, had not only the general principle of the Morse system but the actual Morse alphabet for letters and numerals been adopted by Capt. Colomb. A modification of Capt. Colomb's system, which many practical trials has convinced me is a great improvement, consists in the substitution of short and long eclipses for short and long flashes. In the system of short and long eclipses, the signal lamp is allowed to show its light uninterruptedly until the signal commences. Then groups of long and short eclipses are produced by a movable screen, worked by the sender of the message, and read off as letters, numerals, or code signals by the receiver or receivers. . . . Whenever the light of a lamp suffices, the eclipse method is decidedly surer, particularly at quick speeds of working, than the flash method, and it has besides the great advantage of showing the receivers exactly where to look for the signals when they come, by keeping the signal lamp always in view in the intervals between signals, instead of keeping it eclipsed in the intervals as in Colomb's method."

Is it too much to hope that before very long a knowledge of the Morse alphabet may form part of the elementary education of every boy and girl in the kingdom? Only then can the public awaken to a sense of the many uses to which such a knowledge could be put.

But there is a third set of conditions where signalling is more necessary as well as more difficult than in either of the other two. In fogs, by day or night, visible signals have to be given up as useless, and audible ones take their place. We may utilise Colomb's code or the Morse alphabet by giving short and long blasts on a steam whistle or fog-horn.

"But here again a very great improvement is to be made. Use instead of the distinction between short and long the distinction between sounds of two different pitches, the higher for the 'dot,' the lower for the 'dash.' Whether in the steam whistle or the fog-horn a very sharp limitation of the duration of the signal is scarcely attainable. There is, in fact, an indecision in the beginning and end of the sound, which renders *quick and sure* Morse signalling by longs and shorts impracticable, and entails a painful slowness, and a want of perfect sureness, especially when the sound is barely audible. Two fog-horns or two steam-whistles, tuned to two different notes, or when the distance is not too great, two notes of a bugle or cornet may be used to telegraph words and sentences with admirable smartness and sureness. Five words a minute are easily attainable. This method has the great advantage that, if the sounds can be heard at all, the distinction between the higher and the lower, or, as we may say for brevity, 'acute' and 'grave,' is unmistakable: whereas the distinction between long and short blasts is lost, or becomes uncertain, long before the sound is inaudible."

To produce powerful blasts of sound differing from each other in pitch the Americans have devised an instrument which is much more effective than the fog-horn or steam-whistle. By the irony of fate sirens are now enlisted in the service of humanity, and no longer lure sailors to destruction. The reform in their morals, however, has been fatal to their romantic charm, for now they are "driven at a uniform rate by clockwork, and the blast is supplied from a steam boiler." But is the change to be regretted when we hear that:—

"Short and long blasts of the siren might be advantageously substituted for short and long blasts of the steam whistle, but *much more advantageously* short blasts of two sirens on the same shaft, or on two shafts geared together, sounding different notes, acute note for the short, grave note for the long. The rapidity and the ready distinctiveness of character of the two notes will then be such that every officer and man will habitually recognise evolutional signals and signals for course and speed, just as in skirmishing every officer and private knows the bugle calls; and the signal-book will be no more needed on the bridge of a ship of war than on the saddle of a field officer. When the admiral desires to alter speed or course for the fleet, his order will be given to the whole fleet simultaneously, and very nearly as fast as he can speak it to his flag captain, and then instantly (without waiting to open signal-books) the other ships will, one after another in order, each in replying give the 'understand,' repeat the numbers expressing course and speed, and make her pennant. In as many quarter-minutes as there are ships under his command, the order will have been thus securely acknowledged by every one of them, and the admiral will sound his signal announcing that the order commences to take effect. Nothing short of this in quickness and sureness of ordering the movements of a fleet ought for a moment to be thought of as tolerable, when it is certain (as it assuredly is) that so much is *readily* attainable."

We have quoted this part of the lecture at considerable length, for we have a strong conviction of its high practical value. The collision between the *Monarch* and the *Raleigh* in Besika Bay, which has happened since the lecture was published, serves to point Sir W. Thomson's moral. We are told that when the squadron was in three lines steaming at about five knots an hour, a signal was made to alter the course, which "from some unexplained cause" was misunderstood by two of the ships—the *Triumph* and the *Invincible*. This brought the latter across the bows of the *Monarch*, which then stopped and reversed engines, but the *Raleigh*, astern of the *Monarch*, kept on her course, the result being a collision, which was fortunately much less serious in its consequences than the costly *Vanguard* experiment, of which this one bid fair to be a repetition. That the signal was misunderstood, not by all the ships, and yet by two of them, seems to prove that much blame cannot be attached either to those who made it, or to those who read it; it is, in fact, the system that is at fault.

TYCHO BRAHÉ

BY the kindness of Dr. Crompton, of Manchester, we are able to publish this week a copy from a photograph of what there is every reason to believe is a contemporary portrait of the great Danish astronomer, Tycho Brahé. This picture is on canvas, and is 3 feet 3¾ inches high, and 2 feet 6¼ inches wide. It represents a man of ruddy complexion, standing and looking forwards. He is bareheaded, has little hair, and that short, of a yellowish colour verging to red. He has very long moustaches and a short beard. In the right upper corner of the picture (that is, to Brahé's right) there is a curious emblematic design, consisting of a round tapering column springing from a square base, around which at its foot are waves. Over the monument is a canopy suspended by a strong chain, a few links only of which are visible, the top being lost in clouds, and the chain itself has flames playing round it. Two Æolic heads (one on each side) are represented as blowing towards the canopy and column. Lower down, and to the right and left of the column, are two hands (one on each side) holding each a jug from which water flows. Clouds and lightning surround the background, the wrists of the hands holding the jugs, and also the Æolic heads. Round the monument is a label not entirely decipherable with the words: "Stans (tectus ?) in solido;" then follows an indistinct word and "igne e. tunda" (*sic*). "Igne et unda" was, no doubt intended. In the left upper corner, in large and distinct letters, is this inscription: "Effigies Tychonis Brahe, Otton. Da. anno 50 completo quo post diutinum in patria exilium libertati desideratæ divino provisu restitutus est."

Dr. Crompton thinks, correctly we believe, that the inscription referred to Brahé's departure from Denmark, and that the "exilium *in* patria" was an allusion to his residence on his island of Huenna, in his observatory, away from the court for twenty years. The emblematic picture evidently implies that nothing (not all the elements) could destroy the monument he had erected to his reputation by his observations, and that they would be protected by Providence.

The portrait then shows Brahé as he was in his fiftieth year, and Dr. Crompton thinks the tenor of the emblems and the inscription seem to be conclusive that the picture was painted after Brahé had left Denmark, most probably between the end of October and the 13th of December, 1597, and Dr. Crompton conjectures that the portrait may have been painted to be engraved for Brahé's "Mechanica."

In connection with this interesting portrait, it may not be inopportune to remind our readers of the main events in Tycho Brahé's life, and of the work on which his fame is grounded.

Tycho Brahé was born at Knudsthorp, an estate of his ancestors, near Helsingborg, in Sweden, on the Sound, December 14, 1546. Copernicus had been dead two years and a half, Galileo was not born till eighteen years after, and Kepler, with whom Tycho was latterly associated, was about twenty-five years his junior. Tycho's father, Otto Brahé was descended from an ancient Swedish family, and Tycho was the second eldest child, there being altogether five sons and four daughters in the family. Tycho, evidently much against his will, was destined for a military career. After the birth of another son, the father being in straitened circumstances, Tycho was adopted by his uncle, George Brahé. Until 1559 he appears to have been educated at home at his uncle's, learning reading and writing and Latin, with occasional instruction in poetry and belles-lettres. As it had now been decided that he should qualify himself for some political office in the kingdom of Denmark, Tycho, in April, 1559, was sent to the University of Copenhagen to prepare for the study of law. It seems to have been while pursuing his studies at Copenhagen that Tycho's mind was first strongly attracted to the study of astronomy. An eclipse of the sun was to happen on August 21, 1560, and Tycho was so struck by the precision with which the various details of the phenomena had been predicted by the astrological almanacs of the time that he was fascinated by, and resolved to master, so wonderful a science as astronomy, more especially, it would seem, that phase of it then universally believed in and cultivated, astrology. The planetary motions seem first to have claimed his attention, and these he studied by means of the *Tabulæ Bergenses* of John Stadius.

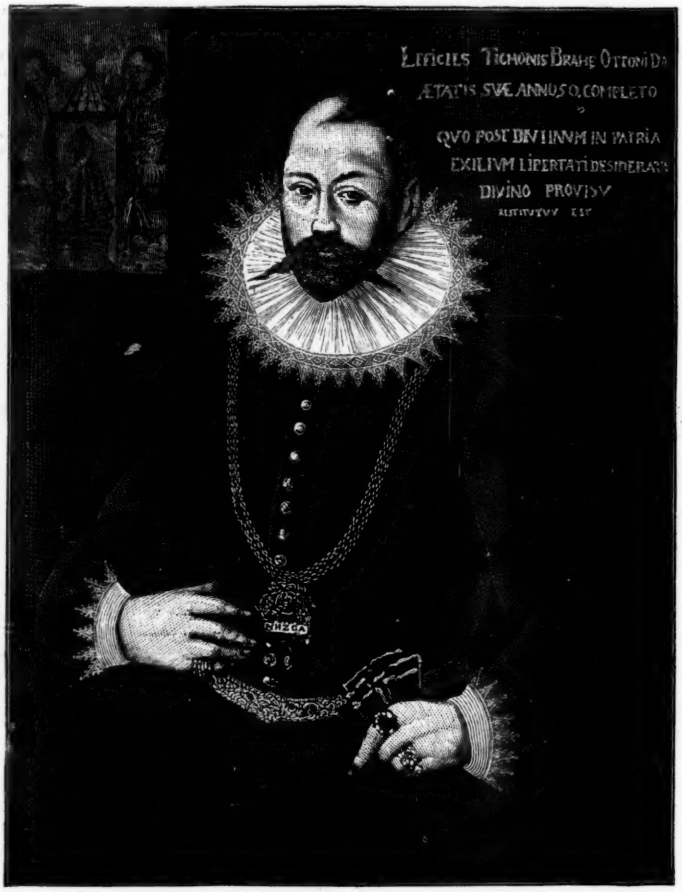
In February, 1562, Tycho was sent to Leipsic, under care of a tutor, to study law. For this, however, he had not the smallest inclination, and devoted all his spare time, when not in presence of his tutor, or when the latter was asleep, and all his pocket-money, to becoming master of the science for which he had contracted a passionate devotion. By means of what books he could command, and with a celestial globe about the size of an orange, he studied the heavens nightly, and soon came to discover that the results obtained by himself differed greatly from those of Stadius. "From that moment," says Brewster, "he seems to have conceived the design of devoting his life to the accurate construction of tables, which he justly regarded as the basis of astronomy." For this purpose he set himself to get up a knowledge of mathematics.

So rapid was Tycho's progress in mastering the astronomy of the day, and so skilful already had he become as an observer, that by means of a simple pair of compasses he discovered that both the Alphonsine and Copernican Tables had erred considerably as to the time of the conjunction of Jupiter and Saturn, which took place in August, 1563. His first instrument seems to have been constructed at the time, a wooden radius, which he got a Leipsic artisan, Scultetus, to devise for him in the manner recommended by Homelius, the professor of mathematics in that city. With this instrument he continued his observations. On his uncle's death, Tycho returned to Denmark about May, 1565, to take possession of the fortune which had been left him. His continued devotion to astronomy greatly offended his friends and relations, who considered such a pursuit as degrading to a noble as trade used to be in this country, and still is in most continental countries. Tycho was so annoyed at the attitude of his friends, that he left Denmark after staying a short time at Wittenberg, took up his residence at Rostock, where he stayed during the years 1566-68, steadily pursuing his celestial observations. It was in a duel at this place that he lost his nose, which was so ingeniously replaced by a substitute of silver and gold, that few could have detected it to be artificial.

From Rostock Tycho proceeded to Augsburg, where with the help of the brothers Hainzel, he constructed a magnificent quadrant of fourteen cubits radius. It was made of beams of oak bound with iron bands, the arcs being covered with plates of brass, divided into 5,400 lines. To enable him to observe distances, a sextant on a similar scale was constructed, and a wooden globe six feet in diameter was begun; hitherto his only instrument was the simple radius made at Leipsic. With his new instruments he continued his observations at Augsburg, with renewed enthusiasm. Tycho returned to his native country in 1571, and found a warm friend in an uncle Steno Bille, who had always taken his nephew's part against the taunts of his other friends, and who assigned him a part of his own house as an observatory. It was while living thus that one of the most notable events in the life of this great astronomical observer occurred, his discovery, November 11, 1572, of a new star in the constellation of Cassiopeia. This wonderful body probably made its first appearance in the heavens on November 5, and continued visible for sixteen months, rapidly increasing in brightness till in the second month it surpassed that

of Jupiter, and was visible at noonday. It then slowly declined, and finally disappeared in March, 1574. It is curious that in the years 945 and 1264 something similar was observed in Cassiopeia, so that in fact the star observed by Tycho Brahé may be a variable one of long period, and if so may be expected to reappear about the year 1885. The colour of this star, moreover, changed; it was at first white, then yellowish, then reddish; afterwards bluish, like Saturn, getting duller and duller as it decreased in apparent size. After much persuasion Tycho, in 1572, published an account of his observations on the new star in a work "De Nova Stella."

Tycho still further offended his relations by marrying a



Portrait of Tycho Brahé (from original painting in possession of Dr. Crompton, of Manchester).

peasant girl in 1573, and shortly after, at the request of the King of Denmark, delivered a course of lectures on astronomy both in its observational and astrological aspects, for in astrology he still continued to believe. After travelling in Germany and Switzerland in 1575, Tycho returned to Denmark and received from the King, Frederick II., an offer which ought to immortalise the name of that monarch. The King seems always really to have admired the astronomer and estimated highly the pursuits to which he had devoted his life, and now realized it to be his duty, as head of the state, to put the man of science in the most favourable position to carry on researches which were then, as now, essentially unremunerative. In fact, in Frederick's treatment of Tycho Brahé we have an early and munificent, and in its results most successful, instance of the endowment of research.

The island of Huen lies in the Sound between Denmark and Sweden, about six miles from the latter and three from the former, and fourteen north-east from Copenhagen. It is somewhat rounded in form, six miles in circumference, and rises from the coast to its centre, where is formed a broad and level table-land. This island the King granted for life to Tycho Brahé, and on it erected a spacious observatory with every convenience for astronomical work and ample accommodation for Tycho's family and servants. A wide space around the central building was inclosed by high substantial walls in the form of a quadrangle, each angle corresponding to one of the cardinal points, and the centre of each wall extending outwards in the form of a semicircle. At the north and south angles were erected turrets of which one was a printing-office and the other the residence of the servants.

This main building was carefully and elaborately planned. It was about 60 feet square, had on the north and south points two round towers for observations, with

Tycho Brahé's Observatory on the Island of Huen.

windows opening to any part of the heavens. Besides a museum and a library there was in a subterranean crypt a laboratory with sixteen furnaces, for we ought to say that Tycho devoted much of his time to the alchemical pursuits of the time, mainly, it would appear, in the hope of being able to find in his crucible the fortune he was prepared to spend on his astronomical pursuits. Tycho Brahé needs neither to be defended nor blamed for his belief in astrology and alchemy; it was a universal belief in his time, a belief only got rid of by slow degrees and the thraldom of which no one man could shake off while at its very height, least of all a man with so much reverence for established beliefs as was Tycho Brahé.

A well forty feet deep distributed water to the building by means of syphons. An instrumental workshop stood outside the rampart to the north, and a sort of farmhouse on the south. The foundation-stone of Uraniberg ("the City of the Heavens"), as Tycho called his establishment, was laid on August 6, 1576.

Large as was Uraniberg, it was found insufficient for the accommodation of all the astronomer's instruments,

and he therefore erected another, partly underground, for the sake of steadiness and solidity, on a hill a little to the south of the former; to this he gave the name of Sternberg ("City of the Stars"), which, by an underground passage, was connected with Uraniberg. Both buildings were in a handsome and regular style of architecture, as contemporary pictures testify, and cost the King of Denmark 100,000 rix dollars (20,000*l.*), and Tycho, it is said, an equal sum. Indeed, Tycho's expenses had so reduced his income, that the king gave him an annual pension of 2,000 dollars, an estate in Norway, and a canonry in the church of Rothschild worth 1,000 dollars per annum. Considering the difference between the value of money then and now, these sums for such a purpose may almost be considered munificent beyond example.

The magnificent set of instruments with which Tycho stocked the buildings were all made under his own superintendence, and according to his own designs, many of them having the merit of original inventions. For number, workmanship, and design, they were unequalled at the time. The following is a list of these instruments as given in Sir David Brewster's excellent memoir of Brahé, in "Martyrs of Science," on which the present notice is mainly based:—

In the South and greater Observatory.

1. A semicircle of solid iron covered with brass, four cubits radius.
2. A sextant of the same materials and size.
3. A quadrant of one and a half cubits radius, and an aximuth circle of three cubits.
4. Ptolemy's parallactic rules, covered with brass, four cubits in the side.
5. Another sextant.
6. Another quadrant, like No. 3.
7. Zodiacal armillaries of melted brass, and turned out of the solid, of three cubits in diameter.

Near this observatory there was a large clock with one wheel two cubits in diameter, and two smaller ones which, like it, indicated hours, minutes, and seconds.

In the South and lesser Observatory.

8. An armillary sphere of brass, with a steel meridian, whose diameter was about four cubits.

In the North Observatory.

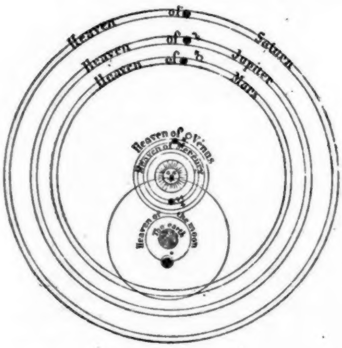
9. Brass parallactic rules, which revolved in azimuth above a brass horizon, twelve feet in diameter.
10. A half sextant, of four cubits radius.
11. A steel sextant.
12. Another half sextant with steel limb, four cubits radius.
13. The parallactic rules of Copernicus.
14. Equatorial armillaries.
15. A quadrant of a solid plate of brass, five cubits in radius, showing every ten seconds.
16. In the museum was the large globe made at Augsburg.

In the Sternberg Observatory.

17. In the central part, a large semicircle, with a brass limb, and three clocks, showing hours, minutes, and seconds.
18. Equatorial armillaries of seven cubits, with semi-armillaries of nine cubits.
19. A sextant of four cubits radius.
20. A geometrical square of iron, with an intercepted quadrant of five cubits, and divided into fifteen seconds.
21. A quadrant of four cubits radius, showing ten seconds, with an azimuth circle.
22. Zodiacal armillaries of brass, with steel meridians, three cubits in diameter.
23. A sextant of brass, kept together by screws, and capable of being taken to pieces for travelling with. Its radius was four cubits.
24. A movable armillary sphere, three cubits in diameter.
25. A quadrant of solid brass, one cubit radius, and divided into minutes by Nonian circles.
26. An astronomical radius of solid brass, three cubits long.
27. An astronomical ring of brass, a cubit in diameter.
28. A small brass astrolabe.

In the island of Huen Tycho resided and carried on his astronomical work for twenty-one years. The island itself was at the time fertile and well cultivated. The astronomer was virtually monarch of all he surveyed. He seems to have been loved by his subjects, and to have led a life of peaceful research and healthy contentment which any man of science of the present day might envy. Teaching was no condition of his tenure of the island and observatory, but his fame, which spread far and wide, attracted numbers of pupils eager to study under the great astronomer. Some of these were trained at the expense of the king, others were sent by different academies and cities, and several were maintained by the astronomer himself. Distinguished visitors were constantly arriving to do homage to the great man, and among these was our own James I., then, however, only James VI. of Scotland. This was in the year 1590, when the king was in Denmark to wed the Princess Anne. He spent eight days at Uraniberg, discussing various subjects with Tycho, and carefully examining all the instruments. He was so much surprised by what he saw and heard, that he granted the astronomer liberty to publish his works in England during seventy years.

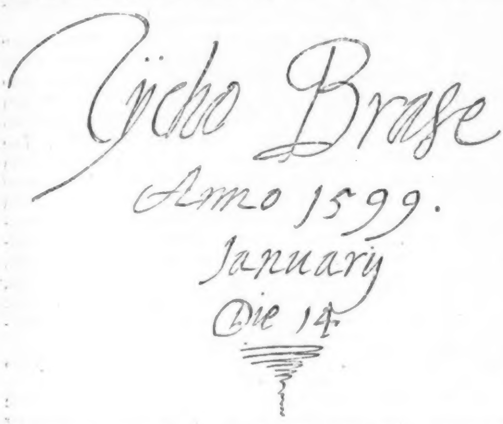
Tycho Brahé might have peaceably ended his days in his pleasant island home, had his great patron Frederick II. lived; he died in April, 1588, and a new king, Christian IV., arose "who knew not Joseph," or at least cared



Tycho Brahé's System.

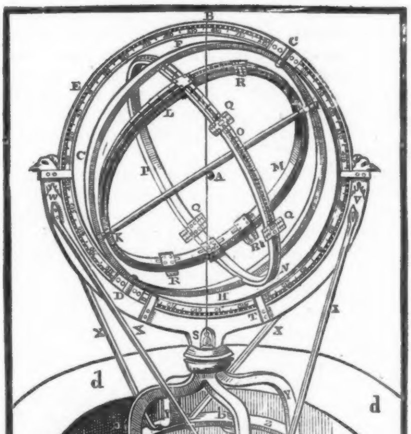
nothing for him and his work. While Frederick reigned his courtiers of course, and many of them sincerely, professed to be passionately fond of astronomy; but as might be expected, Frederick's munificent kindness to Tycho made him many envious enemies. He continued to be tolerated for several years after the death of Frederick, but at last the young king's mind became so poisoned against Tycho by some of the courtiers, that he was deprived of his pension, his estate in Norway, and his canonry. With a wife, five sons, and four daughters, it was scarcely possible for him now to continue his work, but he stayed on till the spring of 1597, when he removed to Copenhagen. His persecution was brought to a crisis by a personal attack made on himself at the instigation of his chief enemy, the President of the Council, Walchendorp, in which one of his servants was injured. Tycho had the spirit to retaliate on his assailants, but almost broken-hearted he resolved to leave a country which had got tired of the glory of its greatest citizen, and which had nothing for him but persecution and insult. Fortunately he had many friends abroad among the nobles and princes of Europe. Among these was Count Henry Rantzau, who lived at the Castle of Wandesburg, near Hamburg, and who invited Tycho to take up his abode with him. Here then, with all his family, he went in the end of 1597, and here he wrote his "Astronomiæ instauratæ Mechanica," containing an account, with illustrations, of his various

instruments and their uses, and also of his chemical labours. This work also contains views and plans of his observatory at Huen, and in the British Museum is an original copy presented by Tycho to his friend, Dr. Thaddeus Haggecius ab Hayck, Chief Physician to the



Kingdom of Bohemia, and bearing the fine autograph which we here reproduce (one-half the size of the original). The work was printed at Wandesburg in 1598, and a copy, along with a MS. catalogue of 1,000

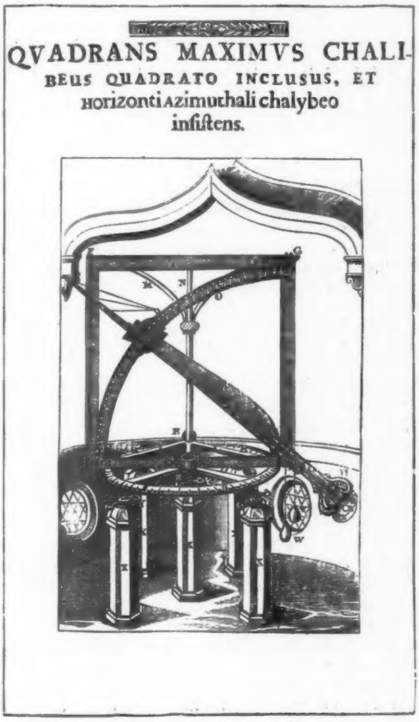
ARMILLÆ ZODIACALES.



Ecliptic Astrolabe (Tycho Brahé) similar to that used by Hipparchus.

stars, was sent to the Emperor Rudolph II., a great lover of alchemy and astronomy. The result was an invitation to Tycho to go to Prague, with an assurance that he would receive the warmest welcome. Thither he went with his family in 1599, and most of his fine set of instruments followed soon after. An annual pension of 3,000 crowns was bestowed upon him, and the castle of Benach given him for residence, though in the beginning of 1601 he removed into Prague, to the house of his late friend Curtius, which the Emperor had purchased and presented to the astronomer. It was at this period that Kepler, then about twenty-nine years of age, lived and worked with Tycho, who procured for him the post of imperial mathematician, for which, however, Kepler never seems to have received any income.

Notwithstanding the munificent treatment of Rudolph, Tycho's misfortunes in Denmark must have told seriously on his health, and his end was near. He had a serious attack on October 13, which so told on his weakened constitution, that although the immediate cause was removed, his strength failed him, and he expired on the



Alt-azimuth of Tycho Brahé.

24th of the same month, within two months of completing his fifty-fifth year.

As to Tycho Brahé's work, we cannot do better than give the following summary by Sir David Brewster :—

"As a practical astronomer, Tycho has not been surpassed by any observer of ancient or of modern times. The splendour and number of his instruments, the ingenuity which he exhibited in inventing new ones and in improving and adding to those which were formerly known, and his skill and assiduity as an observer, have given a character to his labours, and a value to his observations, which will be appreciated to the latest posterity. The appearance of the new star in 1572 led him to form a catalogue of 777 stars, vastly superior in accuracy to those of Hipparchus and Ulugh Beig. His improvements on the lunar theory were still more valuable. He discovered the important inequality called the *variation*, and likewise the annual inequality which depends on the position of the earth in its orbit. He discovered, also,

the inequality in the inclination of the moon's orbit, and in the motion of her nodes. He determined with new accuracy the astronomical refractions from an altitude of 45° down to the horizon, where he found it to be 34′; and he made a vast collection of observations on the planets, which formed the groundwork of Kepler's discoveries, and the basis of the Rudolphine Tables."

MINIATURE PHYSICAL GEOLOGY

THERE have appeared from time to time in the columns of NATURE, interesting and instructive letters on the subject of Miniature Physical Geology. May I be allowed to continue this subject, by pointing out a few lessons which may be learnt during spare half-hours on Ramsgate Sands.

Not far to the east of the harbour, there bubbles up a little stream, which, when the tide is low, flows for a considerable distance over the sands before it reaches the sea. Small as it is, this offers an excellent miniature example of a large river, and from it several things may be learnt. In the first place the river, when carefully watched, is seen repeatedly, and with more or less rapidity, to change its course. This is effected by the deflection, from some cause or other, of the main course of the stream against one bank; the result of which is that the bank is forced to recede, and, as it does so, it ceases to be a shelving slope, and becomes a tiny cliff of greater or less relative height. This bank continues to be rapidly undermined by the action of the stream, and the upper portions, now and again, topple over, with a little splash, into the water, in a manner with which those who have travelled on the Mississippi are well acquainted. In this way a bold curve is formed, which *increases in length down-stream.*

In the meanwhile, on the opposite shore of the river, sand is deposited, and, as the river cuts its way downwards, this portion is left high and dry.

But, ere long, the deep water channel shifts—often rapidly, and without apparent cause—and the miniature river tends to resume a straight course; it recedes from its bank cliffs, and soon a tract of comparatively level dry land separates these banks from the stream. After advancing, however, for a while in this direction, until it there forms a curve similar to the one described above, it once more swings in the direction of its former course, until, by a continuance of the same processes, a broad valley is formed, with beautifully-marked river terraces on either side, showing the length of swing of the river on each occasion that it oscillates to and fro.

In the midst of the stream sand islands are from time to time formed, partly by the deepening of the main channel on one side or the other; but, no sooner has the sand of which they are composed become dry, than the treacherous stream commences the destruction of that which itself had produced.

This is exactly what is continually taking place in the Delta areas of most great rivers. In the Pará branch of the Amazons a large island (Parraqueet Island) has, within the last quarter of a century, completely disappeared. The Ihla Nova has arisen, and is now covered with a luxuriant vegetation.

During the repeated changes in the course of our miniature river, it is possible to watch the deposition of a layer of coarse sand on the partially-eroded surface of a bed of finer material, and it is interesting and instructive to notice how great a body of the coarse material is *dragged* along the bottom. Even in the most sluggish of my miniature streams the sand-grains might be seen rolling over and over each other as they travelled seawards.

In the more muddy flats of Pegwell Bay, I, on one occasion, had an opportunity of witnessing the formation of that which is known on the Mississippi as a "cut-off." The miniature stream bent round in a great loop, and as the flow of the water caused the concave banks to recede, the loop was gradually converted into a circle of water, and, the main stream flowing through the shortest course, left a "horse-shoe" lake, which was in time almost completely shut off from the miniature river.

Perhaps one of the most interesting of these spare half-hours may be spent in watching the formation of deltas. Numbers of these miniature rivers flow into pools, which are miniature seas or lakes. I have often seen one of the streams in the course of an hour fill up a considerable bay, and push its delta far out to sea. The grains of sand, when they come to rest in the pool, form a slope of very constant angle, which, by a number of measurements, I found to be 40° for coarse sand, and 34° for fine sand, the average angle being 36°. By watching the advance of the delta, the formation of false bedding may be seen in actual progress. But these pools, or miniature seas, which lie in depressions in the chalk, offer a field for the study of marine denudation. One may see, for instance, the waves advancing over a newly-formed delta, planing off the upper portion, and forming tiny cliffs of delta material, but leaving the deeper parts of the slope of the deposit intact.

Again, during gentle and steady breezes one may see the formation of drift-currents. I remember watching with interest such a current, which flowed between tiny chalk cliffs through the straits which separated two miniature seas; the most instructive point being that the finer grains of sand at the bottom of the straits, where the water was some 7 inches deep, were rolling over each other in such a manner as to prove the existence of an under-current setting *in the opposite direction* to that in which the surface-current was flowing.

There are many other lessons which may be learnt—such as the formation of fan-deposits (similar to those so plentiful in the Rhone valley and elsewhere in Switzerland), which are formed at the foot of the miniature chalk mountains that stand out from the sand; and the stoppage of the sand ripples, or miniature sand dunes, by the tiniest stream, reminding us of the way in which the Nile has preserved Egypt from total obliteration by this material; but I have already occupied enough of your space.

My object in drawing attention to such matters of ordinary observation is to induce students of physical geology to go out and observe these things for themselves. If, after a morning's study of Lyell's "Principles," the young geologist will devote an hour's careful observation to miniature physical geology, with sketch and note-book in hand, he will find that his conceptions have a reality and a solidity which could not have been evolved in the study at home, while at the same time he will find it more easy to follow, when he shall have the opportunity, the workings of nature on a grander scale.

C. LLOYD MORGAN

TESTIMONIAL TO MR. DARWIN.—EVOLUTION IN THE NETHERLANDS

WE have great pleasure in printing the following correspondence:—

To the Editor of NATURE.

Utrecht, February 20, 1877

On the sixty-ninth birthday of your great countryman, Mr. Charles Darwin, an album with 217 photographs of his admirers in the Netherlands, among whom are eighty-one Doctors and twenty-one University Professors, was presented to him. To the album was joined a letter, of which you will find a copy here inclosed, with the answer of Mr. Darwin.

I suppose you will like to give to both letters a place in your very estimable journal, and therefore I have the honour to forward them to you.

P. HARTING,
Professor, University, Utrecht.

Rotterdam, 6th February, 1877

SIR,—In the early part of the present century there resided in Amsterdam a physician, Dr. J. E. Doornik, who, in 1816, took his departure for Java, and passed the remainder of his life for the greater part in India. His name, though little known elsewhere than in the Netherlands, yet well deserves to be held in remembrance, since he occupies an honourable place among the pioneers of the theory of development. Among his numerous publications on natural philosophy, with a view to this, are worthy of mention his "Wijsgeerig-natuurkundig onderzoek aangaande den vorspronkelijken mensch en de vorspronkelijke stammen van deszelfs geslacht" ("Philosophic Researches concerning Original Man and the Origin of his Species"), and his treatise, "Over het begrip van levenskracht uit een geologisch oogpunt beschouwd" ("On the Idea of Vitality considered from a Geological Point of View"). The first already appeared in 1808; the latter, though written about the same time, was published in 1816, together with other papers more or less similar in tendency, under the title of "Wijsgeerig-natuurkundige verhandelingen" ("Treatises on the Philosophy of Natural History"). In these publications we recognise Doornik as a decided advocate of the theory that the various modifications in which life was revealed in consecutive times originated each from the other. He already occupies the point of vantage on which, shortly afterwards, Lamarck, with reference to the animal kingdom, and in his wake, Prévost and Lyell, with respect to the geological history of our globe, have taken their stand.

Yet the seeds scattered by Dr. Doornik did not take root in fertile soil. It is true that a Groningen professor, G. Bakker, combated at great length some of his arguments regarding the origin of man; it attracted but little public attention, and they soon passed into oblivion.

A generation had passed away ere the theory of evolution began to attract more attention in the Netherlands. The impulse was given by the appearance of the well-known work, "Vestiges of the Natural History of Creation," of which a Dutch translation was published in 1849 by Dr. T. H. van den Broek, Professor of Chemistry at the Military Medical College in Utrecht, with an introductory preface by the celebrated chemist, Prof. G. T. Mulder, as well known in England as elsewhere. This work excited a lively controversy, but its opponents were more numerous than its partisans. Remarkably enough, it found more favour with the general public, and especially with some theologians of liberal principles, than with the representatives of the natural sciences. The majority of zoologists and botanists of any celebrity in the Netherlands looked upon the writer's opinions as a chimera, and speculated on the weaker points rather than on the merits of the work. Notwithstanding, this presented no obstacle to a comparative success, and in 1854, even a third edition of the translation was published, enriched by the translator with numerous annotations.

Among the few Dutch *savants* to recognise the light which the theory of development spreads over creation, must be mentioned two Utrecht professors, viz., F. C. Donders and P. Harting. The former, in his inaugural address pronounced in 1848, "De Harmonie van het dierlijk leven, de openbaring van wetten" ("The Harmony of Animal Life, the Revelation of Laws"), expressed his opinion that, in the gradual change of form consequent upon change of circumstances, may lie the cause of the origin of differences which we are now wont to designate as species. The latter, in the winter of 1856, delivered a series of lectures before a mixed audience, on "The History of Creation," which he published the following year under the title of "Voorwereldlijke Scheppingen" ("Antemundane Creations"), with a diffuse supplement devoted to a critical consideration of the theory of development. Though herein he came to a standstill with a "non liquet," yet it cannot be denied that there gleamed through it his prepossession in favour of a theory which several years later his famed and learned colleague, J. van der Hoeven, Professor at Leyden, making a well-known French writer's words his own, was accustomed to signalise as an explanation, "de l'inconnu par l'impossible."

In 1858 your illustrious countryman, Sir Charles Lyell, was staying for a few days in Utrecht. In the course of conversations with this distinguished *savant* on the theory of development, for which Lyell himself, at least in his writings, had shown himself no pleader, the learned of this country were first made observant of what had been and what was being done in that direction in England. He attracted attention to the treatise of Wallace in the Journal of the Linnean Society, and related how his friend Darwin had been occupied for years in an earnest study of this subject, and that ere long a work would appear from his pen, which, in his opinion, would make a considerable impression. From these conversations it was evident that Lyell himself was wavering. In the following edition of his "Principles of Geology," he declared himself, as we know, a partisan of the hypothesis of development, and Prof. Harting speedily followed in the same track. In his "Algemeene Dierkunde" ("General Zoology"), published in 1862, he was able to declare himself with full conviction a partisan of this hypothesis. Also another famous *savant*, Miquel, Professor of Botany at Utrecht, who had previously declared himself an opponent of the Theory of Development, became a convert to it in his later years, for although this is not expressed in his published writings, it was clearly manifest in his private conversation and in his lectures. To what must this conversion be attributed? With Harting and Miquel, as well as with Lyell and so many others in every country of Europe, this was the fruit produced by the study of your "Origin of Species," published in 1859, which first furnished one vast basis for the theory of development. That work, translated into Dutch by Dr. F. C. Winkler, now conservator of the Geological, Mineralogical, and Palæontological collections in "Feyler's Foundation" at Haarlem excited great and general interest. It is true that a theory, striking so keenly and so deep at the roots of existing opinions and prejudices, could not be expected at once to meet with general approbation. Many even amongst naturalists offered vehement opposition. Prof. J. van der Hoeven, bred up as he was in the school of Cuvier, endeavoured to administer an antidote for what he regarded as a baneful poison by translating into our tongue Hopkins' well-known article in *Fraser's Magazine*. However, neither this production nor the professor's influence over his students could withstand the current, especially when, after his death, the German zoologist, Prof. Emil Selenka, now Professor of Zoology at Erlangen, was appointed at Leyden. A decided advocate of your theory, he awakened in the younger zoologists a lively enthusiasm, and founded a school in which the conviction survives that the theory of development is the key to the explanation of the History of Creation.

In Utrecht, Prof. Harting, with convictions more and more decided, was busy in the same direction; and Selenka's successor in Leyden, Prof. C. K. Hoffmann, did not remain in the rear. Other names, among which are Groningen and Amsterdam professors, might here be cited. By the translation of your "Descent of Man" and "The Expressions of the Emotions in Man and Animals," with copious explanatory notes and by various original papers and translations treating on your theory, Dr. Hartogh Heys van Zouteveen has also largely contributed to the more general spread of your opinions in the Netherlands.

To testify how generally they are held in esteem among the younger zoologists and botanists, and more and more obtain among professors of analogous branches in this country, we might refer to a multitude of less important papers and articles in the periodicals.

This, however, we deem superfluous, since by offering for your acceptance an album, containing the portraits of a number of professional and amateur naturalists in the Netherlands, we offer a convincing proof of our estimation of your indefatigable endeavours in the promotion of science and our admiration of you, Sir, as the cynosure in this untrodden path. We recognise with pleasure Dr. Hartogh Heys van Zouteveen as the primary mover of such a demonstration of our homage. The execution, however, devolved upon the directors of the "Netherland Zoological Society," who reasoned that, with the presentation of this unpretending mark of esteem, a few words on the History of the Theory of Development in the Netherlands would not be entirely unacceptable, the more so, since this historic sketch clearly shows that, albeit some ideas in that direction had already been suggested here, yet to you alone reverts the honour of having formed by your writings a school of zealous and convinced partisans of the theory of development.

Among the names in the accompanying list you will observe several professors of Natural History, Anatomy, and Physiology at the three Dutch Universities, the "Athenæum Illustre" of Amsterdam, and the Polytechnical Academy of Delft, the Con-

servators of the Zoological Museums, the Directors of the Zoological Gardens, and several lecturers on zoology and botany at the High Burghal Schools.

Accept, then, Sir, on your sixty-ninth birthday, this testimony of regard and esteem, not for any value it can have for you, but as a proof, which we are persuaded cannot but afford you some satisfaction, that the seeds by you so liberally strewn have also fallen on fertile soil in the Netherlands.

We are, Sir, &c.,
The Directors of the Netherlands
Zoological Society,
(Signed) President, A. A. VAN BEMMELEN
Secretary, H. T. VETH

The following is Mr. Darwin's reply :—

Down, Beckenham, February 12

SIR,—I received yesterday the magnificent present of the album, together with your letter. I hope that you will endeavour to find some means to express to the 217 distinguished observers and lovers of natural science, who have sent me their photographs, my gratitude for their extreme kindness. I feel deeply gratified by this gift, and I do not think that any testimonial more honourable to me could have been imagined. I am well aware that my books could never have been written, and would not have made any impression on the public mind, had not an immense amount of material been collected by a long series of admirable observers, and it is to them that honour is chiefly due.

I suppose that every worker at science occasionally feels depressed, and doubts whether what he has published has been worth the labour which it has cost him; but for the remaining years of my life, whenever I want cheering, I will look at the portraits of my distinguished co-workers in the field of science, and remember their generous sympathy. When I die the album will be a most precious bequest to my children. I must further express my obligation for the very interesting history contained in your letter of the progress of opinion in the Netherlands, with respect to evolution, the whole of which is quite new to me. I must again thank all my kind friends from my heart for their ever-memorable testimonial, and

I remain, Sir,
Your obliged and grateful servant,
(Signed) CHARLES R. DARWIN

THE NORWEGIAN NORTH-SEA EXPEDITION OF 1876[1]

Zoological Researches

AMONG the various scientific objects of our expedition the examination of the biology of those parts of the ocean which we traversed was one of the most important. We had with this view equipped ourselves in the best way with all the apparatus required for the purpose (dredges, trawl-nets, swabs, sieves, &c.), chiefly after the newest English models, a considerable quantity of ropes of various kinds, and heavy iron weights to hold the apparatus to the bottom were also stowed away in the hold of the vessel. There was besides procured a large quantity of glass vessels of different sizes and kinds, from small test-tubes to cylinders a foot in diameter, and a considerable stock of spirits for preserving the specimens that might be collected.

That the zoological material that might be brought up with the apparatus we have named might be arranged and the preliminary examinations made, which would be of great importance for the later working out, we considered it indispensable that as many zoologists as possible should accompany the expedition; we also thought it right that a skilful artist should always be at hand. The zoological party consisted of Overlæge Danielssen, Grosserer Friele, and myself, and as artist we were fortunate enough to engage Herr Schiertz, landscape-painter, whose practised pencil and keen, all-embracing faculty of observation were exceedingly useful to us. There is a series of masterly-coloured pictures from his hand which will be a true ornament to the zoological treatises, which in course of time will be published on the work of the expedition.

The zoological work was divided in this way:—Overlæge Danielssen and Dr. Koren undertook the Echinodermata, Gephyreerna, and Corals; Grosserer Friele, the Mollusca; Dr. Hansen, the Annelida; and I myself the other classes, the Crustacea, Pycnogonida, Polyzoa, Hydroida, Spongia, together with the lowest organisms standing on the boundary line between the animal and vegetable kingdoms (Foraminifera, Radiolaria, and Diatomacea), and that department of the researches which eventually concerns our salt-water fisheries. We have all been occupied for a considerable time in working out each his own portion of the collected material. But as this has been extraordinarily abundant, it has not been possible for any of us to bring his examination to a conclusion so that a detailed account of it can be given. As, besides, the more special results will be reserved for the collective work, which it is proposed to publish when the expeditions are concluded, it will be sufficient here to state some of the most important results of the expedition. It may also here be mentioned that these researches, carried on far out in the open sea from a comparatively small vessel, and at depths approaching 2,000 fathoms, are, even under the most favourable circumstances, attended with extraordinary difficulties, and occupy a comparatively long time. That we, notwithstanding the exceedingly unfavourable state of the weather during the expedition, were able to obtain such an abundance of zoological material, is due to the skilful and intelligent way in which the work was carried out by Lieut. Petersen, to whom Capt. Wille's command was given over.

During our expedition we had in all employed the dredge from the vessel sixteen times, the trawl-net twelve times, both these together twice, and the swabs but once; there were thus no fewer than thirty-one separate casts, and of these only a few were unsuccessful, while most of them gave very satisfactory results. A net was also employed for examining the marine animals occurring in the upper stratum. Boat dredgings were also undertaken in Sogne Fiord, at Husoe, at Thorshaven in the Færoe Islands, and in the harbour at Reykjavik. Without entering on any detailed specification of the numerous animal forms thus brought from the depths of the sea, I will merely state that there are interesting species, new to science, of nearly all classes, of which complete descriptions and drawings will by-and-by be published.

The greatest depth reached during the expedition was about 2,000 fathoms, almost half-way between Norway and Iceland; there were several casts at depths of over 1,000 fathoms. The zoological researches were begun in Sogne Fiord, where the considerable depth of 650 fathoms was reached, the greatest depth which up to that time had been examined on our coasts. We found here the common deep-sea fauna known from earlier researches, viz., of Hardanger Fiord, and various rarities were collected; among others a well-preserved specimen of the remarkable family, Brisinga, discovered by Asbjœrnsen (*B. coronata*, G. D. Sars), several specimens of the *Priapuloides bicaudata*, Danielssen, and great numbers of the beautiful haired *Munida tenuimana*, G. D. Sars, of which previously only very few specimens had been found.

Our researches, however, first attained their peculiar interest when we reached the extended barrier that lies along our coast on the west, the uttermost limit of which forms the so-called Havbro. Here below 300 fathoms begins the yet little examined cold area, with a bottom-temperature of from 0° to 1·6° C., and the fauna now, in correspondence with this temperature, exhibits a very peculiar character, totally different from that on our south and west coasts. Seventeen of our casts were in the cold area, and we have thus some idea of the peculiar physical and biological conditions prevailing there.

Over the extensive depression which occupies the greater part of the expanse of sea between Norway on the one side, and the Færoe Islands and Iceland on the other, the bottom below 1,000 fathoms appears everywhere to consist of a very peculiar, loose, but very adhesive, exceedingly light, nearly greyish white clay, which is very strongly calcareous, and, on being washed or passed through a sieve, appears to consist almost exclusively of shells of a little, low organism, belonging to the Foraminifera, Biloculina. We have therefore named this deep-sea clay Biloculina clay, to distinguish it from the kind of clay which occurs in the warm area at a great depth in the Atlantic Ocean, and which is called, after a very different Foraminifer, Globigerina. The Biloculina clay of the cold area contains a larger quantity of lime than the Globigerina clay of the Atlantic. It gives off, when treated with an acid, an uncommonly large quantity of gas, and when it is pressed and dried, it is converted in a short time into a very hard and compact sort of limestone. We have here a complete chalk or limestone formation coming into existence, and the fauna occurring here also bears a considerable impress of

[1] By Prof. G. D. Sars. From *Dagbladet*, January 26 and 27.

its ancient origin and close alliance with the organic remains preserved in the fossiliferous strata from the close of the Secondary period. First of all may here be named a fine, probably new Crinoid, over a span long, which was here obtained in numerous living specimens, and which shows an unmistakable resemblance to a few of the oldest fossil forms of this, in our time, almost extinct animal group; next a very peculiar and interesting holothuroid animal, colossal chalk sponges, and large numbers of a new and very peculiar Pycnogonide, also a remarkable blood-red coloured Crangon (*Ræke*) with integuments thin as paper (Hymenocaris), besides several lower crustacea, for the most part new; the mollusc commonly occurring here is that which is so characteristic of our older glacial clay, the *Siphonodentalium vitreum*, M. Sars, which on our coast is first found living in the most northerly part of Finmark. The fauna in these great depths, though peculiarly interesting, both with reference to zoology and geology, appears however as a whole to be rather poor and without variety. The contrary is the case where the bottom begins to rise towards the sea banks. Here we find at a depth of 400 to 900 fathoms, but still within the cold area, an uncommonly abundant and varied animal life. Quite contrary to what we might be inclined to expect from the prevailing low temperature, so far is there from being any trace of hindering or preventing the development of animal life, in comparison with our coast fauna, that we find the rather as we go downwards an exceedingly remarkable luxuriance in the development of the fauna expressed both in the numerous and varied animal forms occurring here, and in the comparatively colossal dimensions which several of these here reach; indeed, one of the marine animals taken up here, belonging to the Umbellularia, had a length of quite eight feet. From the specimens which we got up with the help of dredges, trawl-nets, and swabs, we have been able, if only approximately, to form a sort of idea of the peculiar physiognomy which the sea-bottom here presents.

Forests of peculiar Cladorhiza, with tree-like branches, here deck the bottom for long stretches. Between the branches sit fast beautiful medusa heads (Euryale), and variegated *fjær-stjerner* (Antedon), and various crustacea, among them the marvellous object, Arcturus Baffini, known from the Polar Sea, and slow-moving Pycnogonida, partly of colossal size (up to a span between the extremities of the feet), creep along between their branches and with the help of their enormously-developed proboscis suck out their organic juices; a whole world of more delicate plant-like animals (Polyzoa and Hydroida) having at the same time fixed their dwellings on the branches and stems of the sponges when dead and deprived of their organic bark substance. In the open spaces between the sponge forests creep along beautiful purple sea-stars (Astropecton) and long-armed Ophiurids, together with numberless Annelids of various kinds, and round about swarm different sorts of Crustacea, long-tailed, bristly Decapoda (Crangon), finely-formed Mysida (Eyrthrops, Panerythrops, Pserdomma), masses of Amphipoda (Anonyx), and Isopoda (Munnopsida). Above all project, like high mast timber in a coppice, the predominating Umbellularia with their delicate straight stems and elegantly-curved crowns set full of fringes of polyps. The light of day does not, properly speaking, penetrate to these great depths, but as a compensation there is produced, by the animals themselves, a splendid illumination of the whole, inasmuch as almost all are strongly phosphorescent, or have the power to produce from their bodies an intense light, by turns bluish, greenish, and reddish.

So often as our bottom-scraper or trawl-net found bottom in that region which, after the animal type that was undoubtedly the most prominent and characteristic, we named the region of the Umbellularia, we were certain to have a rich zoological prize, and the day was indeed in most cases unfortunately quite too short for the proper examination and preservation of all those treasures fetched up from the depths of the sea.

Higher up, in a depth of 300 to 100 fathoms, and at a distance from the coast of from ten to twenty Norwegian miles (about 70 to 140 English), begins that extensive barrier which forms, as it were, the foundation on which our land rests, and by which the cold Polar Sea depths are shut off from it. This barrier begins in most cases with a hard, stony bottom, so that our dredgings were here attended with great difficulties. Numerous rolled stones, whose smooth rounded forms and worn edges clearly enough show that they had at one time been subjected to the powerful action of ice, lie here strewn on the sometimes very uneven bottom, consisting of solid rock, and prevent the dredge from acting properly, or fill up its mouth so that only incomplete specimens of the animal world living here can be obtained. The fauna has here quite altered its character, and more resembles that common on our coasts; but it appears to be a rule that below this point at the border of the barrier it is considerably richer than that nearer the shore, a fact which also stands in full agreement with the long known great abundance of fish at these places.

When we finally survey what here can only in a general way be pointed out concerning the physical and biological relations of the tract of sea we traversed we may, both in a physiographic and a zoological respect, divide the depths of the sea surrounding our country into two regions differing greatly in character, namely, the warm and the cold areas. The first occupies the whole Skagerak and the North Sea, and farther north the sea along our coast to a distance of ten to twenty Norwegian miles, including herein all the fiords cutting deeply into the land, and stretches towards the north to the northernmost point of Finmark. The cold area commences where the bottom begins to sink from the sea-banks towards the great deeps lying beyond them, and towards the south reaches nearly to the latitude of Stadt, and towards the south-west extends in the form of a narrow wedge in between the Færoe and the Shetland Islands as far as the 60th degree of latitude. Towards the north the cold area extends to the Pole, which properly is its central point. We have examined it at one of the points where it extends farthest to the south, where it has shown itself to be everywhere very sharply and distinctly defined from the warm area. As we proceed farther north, the boundary between the two becomes less distinctly marked, inasmuch as the cold area little by little raises itself from the depths, until in the Polar Sea it finally rises to the surface, and thus also occupies the littoral region, the warm area being at the same time greatly diminished in extent. The close correspondence with the above-described peculiar physical conditions in the sea surrounding our country has been to a very considerable degree explained by the experience obtained during our expedition, and thus a very important contribution has been made to the meteorology of the sea in general. A fuller explanation of these purely physical phenomena is also of the greatest importance to us zoologists for the right understanding of the different biological conditions in the sea; but as such an explanation belongs properly to the physical-meteorological researches, I will not here enter farther upon it, but keep to the more purely zoological side of the matter.

With regard to the character of the fauna in the cold area, it is purely arctic or glacial without any southern mixture whatever; and we have already been able to identify several of our species with types before collected in the Polar Sea during the various North Polar expeditions fitted out in Sweden, Germany, England, and America. In higher latitudes those animal types, which in that part of the sea which we examined are only found below the 400 fathoms' line, live in comparatively shallow bands, indeed even in the upper stratum of the sea, which interesting fact appears still further to confirm the view held by several men of science that the distribution of animal life in the sea is mainly dependent on temperature, depth having only a comparatively limited influence upon it. The purely Arctic fauna which prevailed on our coasts during the Glacial period, and which has left behind its traces in the glacial clays and in the older glacial shell banks, has, under altered meteorological conditions, little by little drawn down to the depths, where the effect of these conditions was less sensible, while the places which it inhabited have been occupied by more southern, immigrating types. At great depths in our fiords which run far into the land, a remnant of the original Arctic fauna has been able to maintain itself. But this is clearly only a fortuitous circumstance, as clearly enough appears from the generally small size and stunted appearance of these animal types, and their complete extinction is probable. This we are now, after having acquired an accurate acquaintance with the temperature of the sea, able to explain on purely physical grounds. For even to those deep pools in our fiords the influence of the milder climatic conditions has at last reached, so that at depths of 650 fathoms there is a temperature of 6° C., which may be supposed to have a prejudicial influence on the growth of these types. On the other hand, the temperature off our sea-banks at a much smaller depth remains unchanged, such as it was in the Glacial period, both here and close to our coast, and therefore we find also here, even at a remarkably southern latitude, no impoverished and stunted, but as luxuriantly developed an Arctic or glacial fauna as high up in the north in the Polar Sea.

The very important light which from the side of meteorology may be thrown on several yet obscure phenomena in the deve-

lopment and distribution of organic life as on the other hand the often considerable aid meteorological researches may obtain from purely biological facts, render it desirable that these two sciences, which may appear very different, do not become strangers to each other but mutually come into closer alliance with the object in view, to contribute to the scientific solution of the many yet unsolved physical and biological problems.

(To be continued.)

OUR ASTRONOMICAL COLUMN

THE BINARY STAR ξ BOOTIS.—Dr. Doberck, of the Markree Observatory, has published elements of this revolving double-star, which appear to represent very satisfactorily the measures up to the present time, allowance being made for some obvious errors of observation. The orbit, which differs materially from those calculated upon shorter series of measures by Mädler, Herschel, and Hind, is as follows :—

Peri-astron passage, 1770·44. Period, 127·97 years.
Node ... 12° 1′ Inclination ... 37° 53′
Node to peri-astron, on orbit ... 130° 54′
Eccentricity ... ... 0·6781
Semi-axis major ... 4″·813

At the epoch 1782·28 these elements give the position 24°·1, distance 3″·64 ; and for 1804·25, position 352°·5, distance 6″·53; for Dembowski's epoch 1870·87 the errors are + 0°·3 and – 0″·11. The following figures are deduced from Dr. Doberck's elements :—

		°		″			°		″
1876·0,	Pos.	283·7	Dist.	4·29	1892·0,	Pos.	224·7	Dist.	2·35
1880·0,	„	274·5	„	3·84	1896·0,	„	188·2	„	1·82
1884·0,	„	262·8	„	3·36	1900·0,	„	111·9	„	1·31
1888·0,	„	247·1	„	2·86					

Dr. Doberck has now investigated elements of σ Coronæ Borealis, τ and λ Ophiuchi, μ^2, 44 and ξ Bootis, γ and ω Leonis, η Cassiopeæ, and several other stars, thus greatly adding to our knowledge of the orbits of the binaries, his discussions being at the same time conducted in a very exhaustive manner, to date.

VARIABLE STARS.—In No. 2,119 of the *Astronomische Nachrichten* are observations of a number of variable stars, made in 1875 by Mr. Chandler of New York. There was a well-marked minimum of that irregular variable α Herculis on August 21 ; the observations of W and X Sagittarii are worthy of note, as they support the results previously given by Prof. Schmidt, of Athens, and are stated to have been made without any "pre-occupation of mind in the observer," who had no previous knowledge of the character of the light variations. Schmidt's period for W, is 7·5933 days, and for X, 7·0119 days ; another star in the same constellation, U Sagittarii of the last catalogue by Prof. Schönfeld, is assigned a period of 6·7452 days. The three stars were added to the variable star list by the indefatigable director of the Observatory at Athens, in the summer of 1866.

Mr. J. E. Gore (Umballa, Punjab) writes, suggesting the variability of Lalande 42360. The place in the catalogue depends upon an observation made August 7, 1793, when the star was rated 7m. Argelander ("Bonn Observations," vol. vii. p. 181) identifies this star with No. 42383 of the catalogue, observed as an 8m., September 29, 1791. Considering that there is an error in the record of the time of transit ; the declinations closely agree.

DAMOISEAU'S TABLES OF JUPITER'S SATELLITES.—Independent extensions of these Tables, which run out in 1880, have been made in Europe and America. Prof. Coffin, superintendent of the American Ephemeris, notifies an extension to 1900, which has been carried into effect by Mr. D. P. Todd, we believe under the superintendence of Prof. Newcomb. The work will be sent to any library or astronomer possessing a copy of the Tables, on application to the office at Washington. Before the time named it may be hoped that both as regards theory and observation, the laborious operation of forming new Tables may be justified by the certainty of obtaining results which will enable us to predict the phenomena of the satellites, with considerably greater accuracy than can be effected by the use of Damoiseau's Tables. And we may also express the hope that as regards systematic observations, the Astronomer-Royal's urgent recommendation will not be lost sight of.

BESSEL'S TREATISES.—Volume iii. of the reprint of the more important of the many papers by Bessel on astronomical and other subjects, which completes the work, was issued a short time since by Dr. Engelmann, and comprises geodesy, physics, and general astronomical subjects, as the libration of the moon, shooting-stars, the mass of Jupiter, and the theory of eclipses. Speaking of the work as a whole, it will prove a very valuable aid to the student of Astronomy, affording him without the labour and difficulty of consulting a number of publications, the means of acquainting himself with the principal memoirs of the illustrious Professor of Königsberg, who may be said to have revolutionised the practice of astronomy. Dr. Busch's "Verzeichniss sämmtlicher Werke, Abhandlungen, Aufsätze, und Bemerkungen, von F. W. Bessel," printed in vol. xxiv. of the Königsberg observations, and subsequently in a separate form, contains 385 articles, and we believe, with only one or two exceptions, Dr. Engelmann's three volumes will be found to contain all that are of more permanent interest and value.

BIOLOGICAL NOTES

THE ELECTRIC EEL.—Since Humboldt's discovery of the electric eel and his observations of its peculiar properties, carried out unfortunately before the discovery of the voltaic pile, strange to say, no attempt has been made to study this remarkable reptile in its natural surroundings. In view of this fact, the Berlin Academy of Sciences sent the well-known histologist and physiologist Dr. Carl Sachs, last September, to the scene of Humboldt's former activities, well equipped with an ample supply of electro-physiological apparatus, and means for carrying out an extensive series of observations. In the last session of the Academy a letter dated December 7 was read from Dr. Sachs, in which he stated that he had safely performed the journey from Caraccas, over the Cordilleras, to the *Llanos*. The gymnotus had disappeared from the neighbourhood of Rastro, where Humboldt's investigations took place, but at a distance of a few miles from the city of Calabozo, a river was found fairly alive with the dreaded *temblador*. In the five days which had elapsed since the discovery of the locality, many valuable results had been afforded by the observations, and there was every prospect that the expedition would yield a large number of new and important additions to our knowledge of the electro-motive organs.

EARLY DEVELOPMENT OF SPONGES.—At a meeting, on February 8, of the Société Vaudoise des Sciences Naturelles, Prof. Forel spoke on an interesting occurrence of an early development of sponges in the Lake of Geneva, due to the unusually mild winter of this year. The fluviatile sponge of the lake consists of a horny skeleton with very fine siliceous spiculæ, covered with a sheet of soft, perforated animal matter. Usually, in autumn, this soft matter leaves the exterior ramifications and condenses under the form of small gemmulæ, half a millimetre in diameter, in the deepest interior parts of the horny skeleton. There it remains until the spring, when it expands anew upon the ramifications, and covers them with a sheet of living animal matter. But this year M. Forel observed on February 2, besides many sponges in their hibernal state, a colony of other sponges which had already reached their full summer development, differing only by a somewhat paler colour

from the usual summer appearance. The occurrence is perfectly explained by the circumstance that the temperature of water in the Lake of Geneva was this year higher by two degrees than the average temperature for many years, which is 6°·3 Cels. for December and 4°·9 for January.

A NEW SPONGE.—Prof. E. Perceval Wright describes (*Proc. R. Irish Acad.*, vol. ii., ser. 2, part 7) a beautiful little sponge found growing on the fronds of some species of Red Seaweeds from the coasts of Australia, of which we give the accompanying illustration. The largest specimens measure not three millimetres in height. The sponge consists of three distinct and well-marked portions: firstly, a small basal disk; secondly, an elongated stem, on the summit of which expands the third portion, or capitulum. The disk is button-shaped, flat, and is formed of an irregular horny framework, twice to three times as broad as the stem. The stem varies in height, and presents the appearance, in some cases, of a series of margined rings, some twenty in number, fastened together one on the top of the other; in others the margins of the rings will be more prominent, and the bodies of the rings will be, as it were, more deeply sunk. In both these cases the horny framework is of a more or less evenly latticed character, the longitudinal lines of the lattice being very prominent. The head portion, in its natural state, probably presents a more or less spherical form, perhaps slightly flattened on the summit, with an indication of being divided into four nearly equal parts, the open space between these leading into the body-cavity of the sponge. In some of the specimens the head portion nearest to the stem seems to have been formed of a somewhat denser framework than the upper portion, so that while being pressed this upper portion has been fractured across. The framework here is of a densely-reticulated kind, in appearance reminding one of the reticulated network of the intracapsular sarcode in Thalassolampe, or of the tissues met with in some Echinoderms. This sponge has been called *Kallispongia archeri*. The wonderful mimetic resemblance which it bears to some Crinoid-forms can scarcely be overlooked. Leaving the texture and composition of the skeleton mass for the moment out of view, and simply looking at its outline—the circular disc-like base, the stem—the profile of which is absolutely the same, except as to size, as that of the pentacrinoid stage of *Antedon rosaceus*, and the slightly cleft head, the resemblance is very great. So far as is known, this is a unique case among the sponges, and one is left to wonder what may be the tiny enemies from which *Kallispongia archeri*, by this complete disguise, conceals itself.

Kallispongia.

WILD DOGS ON THE OBI.—An interesting occurrence of dogs which have reverted to the wild state is reported by M. Poliakoff from the neighbourhoods of Soorgoot on the Obi, and Tobolsk. The size of these animals is somewhat larger than that of the dogs of the locality, but less than that of wolves; their habits being rather remarkable the inhabitants would not acknowledge them to be common dogs, and the hunters preserved the skins of the individuals they happened to kill, as rare samples of unknown animals. M. Poliakoff could not, however, detect in the skins he describes any deviations from the common dog type, except the larger size, and perhaps a somewhat greater length of body, with comparatively shorter legs (at Tobolsk). But the habits of these animals are certainly wolf-like; they inhabit woods and live by hunting, which they carry on in companies. Ten individuals were thus well-known at Soorgoot as hunting in company the wild reindeer, and latterly they approached the settlements, causing a panic among the inhabitants by the ravages they made among cattle. They hunted always together, assailing their prey simultaneously. They are reported also to be far more voracious than wolves, and their habits, M. Poliakoff observes, resemble much those of the red highland wolf (*Canis alpinus*) of Eastern Siberia.

THE WOODPECKER.—At the session of the German Ornithological Society, on February 8, Prof. Altum gave an interesting address on the ordinary woodpecker, embodying a portion of the results of over seven years' observation. With regard to the question of how the woodpecker finds the trees inhabited by insects, he had noticed that it almost invariably resorted to such trees as bore the diseased look consequent upon the presence of insects, manifested by the smallness and fewness of the leaves, the absence of the usual fresh colour of the bark, &c. In some cases it is deceived, especially where new varieties of trees have been set out. When it has detected a hole bored in the bark by insects, it follows the course of the passage under the bark by a gentle tapping with its bill, until it reaches the place where the larvæ are situated, when, by tearing off large portions of bark, its food is laid bare. Among the insects not eaten by the woodpecker are such as the *Cerombyx heros*, which bores too deep into the wood, or small insects such as the *Bostichidæ*, living in the bark of the pine tree, which is difficult to penetrate. The presence of the woodpecker is good for a forest, in so far as it destroys the insects upon the trees. It however injures the latter frequently by tearing off large pieces of bark, and indirectly by eating the useful wood-ants. The statement that woodpeckers made incisions in trees free from insects, for the purpose of sucking the sap, was disproved by Prof. Altum, on ground of repeated observations.

SAGACITY OF A LOBSTER.—A few days ago, at the Rothesay Aquarium, a tank containing flat fishes was emptied, and a flounder of eight inches in length was inadvertently left buried in the shingle, where it died. On refilling the tank it was tenanted by three lobsters (*Homarus marinus*), one of which is an aged veteran of unusual size, bearing an honourable array of barnacles; and he soon brought to light the hidden flounder, with which he retired to a corner. In a short time it was noticed that the flounder was *non est*. It was impossible the lobster could have eaten it all in the interim, and the handle of a net revealed the fact that, upon the approach of the two smaller lobsters the larger one had buried the flounder beneath a heap of shingle, on which he now mounted guard. Five times within two hours was the fish unearthed, and as often did the lobster shovel the gravel over it with his huge claws, each time ascending the pile and turning his bold defensive front to his companions.

THE INFLUENCE OF TEMPERATURE ON THE NERVE- AND MUSCLE-CURRENT.—M. Steiner has proved (*Reichert's Archiv*) that the electromotive force of the nerve-current from 2° upwards, is greater the higher the temperature, that it reaches a maximum between 14° and 25°, and at higher temperatures decreases again. The force of the muscle-current is likewise, from 5° upwards, greater the higher the temperature; it has its maximum between 35° and 40°, and at higher temperatures becomes less again, till, when rigidity sets in, it is almost *nil*. Thus, for the nerve and muscle-current, as well as for other functions of

living organic forms, there is a *temperature optimum*; which is as distinctly marked when, by heating, we rise to it from lower temperatures, as when we descend to it by cooling from higher temperatures.

FERTILISATION OF FLOWERS BY BIRDS.—In an interesting article by Prof. Asa Gray, in the *American Journal of Science and Arts*, on Darwin's recent work the writer notices what Darwin says about the fertilising of flowers by birds, chiefly humming-birds. The frequenting of the flowers of *Impatiens* is the only case cited from the United States; and Dr. Gray asks: "Can it be that there are no references in print to the most familiar fact that our humming-bird is very fond of sucking the blossoms of trumpet creeper (*Tecoma radicans*) and of honeysuckles? Both these are, in size and arrangement of parts, well adapted to be thus cross-fertilised."

A NEW PARASITIC GREEN ALGA.—Not very long since it was thought that the want of chlorophyll determined the parasitism of plants, and it is still true that the want of this green colouring substance serves to distinguish between fungi and algæ. It is also true that the former need already-formed carbon compounds, but it is still thought that chlorophyll-bearing plants not only do not require to find these compounds ready formed, but that they are absolutely unable to assimilate them. It was therefore a fact of great interest when Prof. Cohn described some years since (1872) a perfectly new chlorophyllaceous alga ("Ueber parasitische Algen" in *Beit. zur Biol. der Pflanzen*, Bd. i. Heft 2; see also W. Archer, *Quart. Journ. Mic. Science*, N.S., vol. xiii.), which he found living as a bright emerald green parasite in the thallus of duck-weed gathered at Breslau. For this the genus Chlorochytrium was established, and *C. lemnæ* was the only species until at a late meeting of the Dublin Microscopical Club, Prof. E. Perceval Wright exhibited and described a second species found growing and developing itself in the mucilaginous tubes of a species of Schizonema, collected on rocks at Howth, near Dublin, between high and low water-marks. There can be no question as to the parasite on the diatom being different from that on the duck-weed, while there is but little difficulty in placing it in Cohn's genus. Smaller in size its emerald lustre is scarcely if at all less than the fresh-water species, and like it its development has not been traced farther than the production of zoospores.

FLORA OF TURKESTAN.—We notice a very interesting communication on the Flora of Turkestan, made by Prof. Regel, the director of the St. Petersburg Botanical Garden, at the last meeting held on January 20, by the Russian Society of Gardening. The special aim of the communication being to advocate the introduction into European gardens of representatives of the flora of Turkestan, Prof. Regel described the numerous, original, and most beautiful species belonging to the *Compositeæ*, *Caryophyllæ*, *Umbelliferæ*, *Papilionaceæ*, *Malvaceæ*, and *Campanulaceæ*, which grow in Turkestan, and which could rank among the best ornaments of our gardens by their variety and beautiful forms and colours. Most of these species are already cultivated with complete success in the St. Petersburg Botanical Garden, and they might be thus introduced in the gardens of Russia and Western Europe. Concluding his communication, Prof. Regel pointed out the remarkable circumstance that in Turkestan, even in hilly tracts, the *Ericaceæ* are totally wanting, whilst they are so common in the highlands of the Alps, of the Caucasus, and even of the Altai.

NOTES

METEOROLOGISTS everywhere will learn with much satisfaction that Dr. Julius Hann, the eminent meteorologist, was appointed, February 10, successor to the late Dr. Jelinek, as Director of the Central-Anstalt für Meteorologie und Erdmagnetismus, Vienna.

FIFTY-SEVEN candidates for election into the Royal Society have offered themselves during the present session.

PROF. A. OPPENHEIM, of Berlin, has accepted the chair of chemistry in the newly-organised Philosophical Faculty at Münster.

PROF. PFEFFER, of Bonn, has accepted the ordinary professorship of Botany in the University of Basel.

THE Treasury have agreed to recommend votes from the Consolidated Fund for 80,000*l.* towards the new buildings devoted to the Science Schools of the University of Edinburgh, in four yearly instalments of 20,000*l.* each. This vote is to supplement a like amount subscribed by the public.

THE marble statue of Sir W. Fairbairn is in the hands of Mr. Geflowski, who obtained the Commission in competition with other eminent sculptors. Besides the statue, which is to stand in the New Town Hall, Manchester, facing the entrance, a Fairbairn scholarship is founded in Owens College, Manchester, out of the funds subscribed. The statue is eight feet high, representing Sir W. Fairbairn standing with papers in his hand as if delivering an address to a scientific audience, the head bare and inclined slightly, and an admirable likeness in the features as well as in the thoughtful expression and quiet energy characteristic of the man.

THE University of Tübingen is making preparations to celebrate its 400th anniversary during the coming month of August. Various historical addresses are in course of preparation, and a work will be issued commemorative of the occasion.

A PUBLIC meeting of the Sanitary Institute of Great Britain will be held at the rooms of the Society of Arts, John Street, Adelphi, on Wednesday, March 14, at 3 P.M., to consider the report recently issued by the Committee appointed by the President of the Local Government Board upon the disposal of town sewage.

HIS Majesty, the Emperor of Brazil, observed the eclipse of the moon on the evening of the 27th, at the Arcetri Observatory. The Emperor took a very lively interest in the phenomenon and discussed with acuteness the hypothesis with which Prof. Tempel, the astronomer, and Prof. Echert tried to explain the varying shades and colours in which the moon appeared during the different phases of obscuration. On Monday last his Majesty assisted at a meeting of the Anthropological Society, when Prof. Mantegazza made some interesting remarks on several Maori skulls, and Prof. Giglioli read an elaborate paper on the ethnology of Brazil.

THE general expenses of the seven Russian universities in 1876 were as follows:—The University of St. Petersburg, 43,500*l.*; of Moscow, 52,850*l.*; of Kieff, 38,375*l.*; of Kazan, 39,500*l.*; of Kharkof, 38,125*l.*; of Odessa, 25,375*l.*; and of Dorpat, 26,625*l.*

WE notice the following more important papers on natural science, among those published by professors of the Moscow University in 1876:—"Observations de Jupiter en 1876," "Profil spectroscopique du Soleil en 1876," and "Sur la Queue de la Comète de 1874," by Prof. Bredikhin, in the *Annales* of the Moscow Observatory; a paper, by Prof. Babukhin, "Ueber die Structur und Verhältnisse elektrischer und pseudo-elektrischer Organen," in the *Archiv für Anatomie und Physiologie*; "Théorie des Dérivées," and "On the Numerical Equations of the Second Degree," by Prof. Bugaïeff, in the Moscow *Mathematical Review* (Russian); the papers of Prof. Markovnikoff on Theine (NATURE, vol. xv. p. 167). An interesting popular lecture on Unicorns,

and on the origin of the myths on them, was delivered at the last anniversary of the University by Prof. Usoff.

M. DUMAS has been nominated president of the Société d'Encouragement pour l'Industrie Nationale. At the last meeting of the Society M. Moutenat exhibited metallic tubes which emit sounds when burning coal is placed in the interior. The sound is modified when the place occupied by the coal has been changed. A copper tube into which metallic gauze has been introduced also emits musical sounds. M. Moutenat is preparing to build large tubes for the International Exhibition of 1878. He hopes the sounds may be heard at a great distance, and if successful he intends to propose this method instead of steam whistles for warning on the sea-coasts.

THE Bradford Scientific Association purpose holding a conversazione and exhibition of scientific instruments and objects on the evenings of April 11 and 12. Exhibits will be arranged under various sections and sub-sections, and contributions will be welcomed.

FROM the Annual Report of the Geologists' Association we learn that the number of members on January 1 was 390.

VOL. I. Part 6, of the *Transactions* of Watford Natural History Society contain papers on the Hertfordshire Bourne, by Mr. John Evans, F.R.S.; on the Hertfordshire Ordnance Bench Marks, by Mr. John Hopkinson, F.L.S.; and on the Polarisation of Light, by Mr. J. N. Harford.

MR. RUDKIN has given notice of his intention to move, at the next meeting of the Court of Common Council, that it be referred to the Gresham Committee to confer with the Mercers' Company as to whether and how the Gresham College foundation can be utilised and extended in connection with the scheme which is now being prosecuted by the Livery Companies for establishing a Central Technical University, with affiliated colleges and institutes, not only in the metropolis and its suburbs, but in the chief centres of industrial life throughout the United Kingdom.

THE Russian Government announces the discovery of valuable silver deposits in several islands of the White Sea.

GRAF WALBURG, a member of Dr. Brehm's expedition to Siberia, is now studying the botanical and palæontological collections at Dorpat. He proposes to undertake this year another journey to Asia and to explore the Caucasus.

THE St. Petersburg papers announce the return of Lieut. Onatsevitch, who has spent two years in the survey of the Northern Pacific shores of Siberia. After having observed the Transit of Venus, Lieut. Onatsevitch engaged in a full and thorough survey of Behring's Strait, extending his soundings into the glacial ocean as far as the ice barrier over a surface of about sixteen square degrees. Further, having at his disposal fourteen chronometers, he has determined many longitudes, and has brought into connection the longitudes formerly determined in the north-east with those recently determined with great accuracy before the Transit of Venus in south-eastern Siberia. The work done by M. Onatsevitch will be the subject of communications at the next meeting of the St. Petersburg Geographical Society.

THE map of the mouth of the Obi, prepared by M. Dahl (who made last summer a detailed survey and soundings when descending the river on board the schooner *Moscow*, built in Tiumen), will appear in the course of a month or two.

THE *Afrikanische Gesellschaft* of Berlin received a few days since news from Dr. von Bary, who at the end of December was on the point of leaving the city of R'hat to penetrate into the mountain region of the Tuareks, in the central part of the Sahara. Hostilities had just ceased between the tribes inhabiting this territory, and there was every probability of his successfully accomplishing the aims of the journey, viz., a careful geological study of this scarcely-known region.

IN the last session of the Berlin Geographical Society, the president, Dr. Bastian, announced that the well-known African traveller, Dr. Gustav Nachtigal, intended to undertake a new journey of exploration into the interior from the coast of equatorial Africa. This field, now rendered vacant by the death of Edward Mohr at Molange, has always been the favourite territory of the German explorers. Dr. Nachtigal's peculiar qualifications for the undertaking, as well as his six years' varied experience in the hardships of African travel, will lend an important character to this new new attempt to penetrate into the unknown interior of the continent.

AT the meeting of the French Geographical Society M. Charles Velain read a paper on the volcanic lakes of the island of Nossi Bé, near Madagascar. The formation of the island is generally volcanic, the north and south parts being of ancient formation, while the central part is of much more recent origin. Besides a number of true volcanic craters, not very high, M. Velain found a great number of crater-lakes or circular troughs, level with the ground and filled with water. These troughs, M. Velain thinks, must have been formed by subterranean explosions, which did not last long enough to enable the lava to reach the surface. These lakes abound in fish, many of which are probably new species; it is impossible, however, to catch them, on account of the number of crocodiles that swarm on the banks.

ENGÄNZUNGSHEFT No. 50 of Petermann's *Geographischee Mittheilungen* contains the first part of a narrative of M. E. de Pruyssenaere's Travels in the Region of the White and the Blue Nile. M. de Pruyssenaere was a young and accomplished Belgian who spent most of the time between 1859 and 1864 in the exploration of the above region, and after much difficulty the editor of the narrative, K. Zöppritz, obtained possession of his journals and notes. Notwithstanding the length of time that has elapsed since M. de Pruyssenaere traversed the region, it will be found that his narrative adds considerably to our knowledge of it. He made many botanical notes, which, we believe, will be published at a future time. Accompanying the narrative is a map of the region, showing the traveller's routes, prepared from his astronomical and trigonometrical observations. M. de Pruyssenaere died in the midst of his travels in 1864, at the early age of thirty-eight years.

PROF. C. JARZ, of Vienna, formerly an artillery officer under the Emperor Maximilian of Mexico, has recently issued a short work on "Ocean Currents of the North Atlantic," with especial reference to the Gulf Stream, embodying much of individual observation. The rotation of the earth is excluded from among the causes producing these phenomena. His theory is essentially that each current has its own particular causes, and that a number of independent compensating forces occasion the character, speed, and direction of the currents.

THE last session of the Hungarian Natural History Society was devoted to a detailed account, by M. von Hantken, of the results of his extensive microscopic researches on the Hungarian limestone formations. The old Tertiary deposits near Ofen were found to consist almost entirely of organic remains, principally Algæ, Foraminifera, and Bryozoa. The Algæ form the chief part of several strata and belong to the genus *Lithothamnium*. Microscopic investigation showed a regular structure of successive layers of cells. In the interstices between the cells of the plants carbonate of lime was gradually deposited, and they were petrified entire. The presence of the remains of Foraminifera and Bryozoa showed a contemporaneous zoogenous and phylogenous growth of the rocks. As the Lithothamnium of the

present day grows only on the sea-shore, it is probable that these Hungarian limestone deposits are coast formations.

In the February session of the Hungarian Geological Society, Prof. Krenner displayed a lately-discovered mineral from Nagyág, which consisted of pure telluride of gold. As is well known, gold does not occur in nature in combination with any member of the sulphur-group except tellurium. A mixture of the tellurides of silver and gold was found recently in California, but this is the first instance of the occurrence of the pure auric telluride in a crystalline state. In view of the fact that gold is the noblest metal, and tellurium one of the rarest elements, the new mineral has been called *Bunsenite*, in order to give a fitting expression of the gratitude of the great chemist's admirers in Hungary for the services rendered to mineralogy by his analytical methods.

A remarkable piece of coral taken off the submarine cable near Port Darwin, is spoken of in a Melbourne paper. It is of the ordinary species, about five inches in height, six inches in diameter at the top, and about two inches at the base. It is perfectly formed, and the base bears the distinct impression of the cable and a few fibres of the coil rope used as a sheath for the telegraphic wire still adhering to it. As the cable has been laid only four years, it is evident that this specimen must have grown to its present height in that time, which seems to prove that the growth of coral is much more rapid than has been supposed.

It is well known that in many places springs of fresh water arise from the bottom of the sea. M. Toselli proposes to make use of them. Their water, brought through flexible tubes held at the surface by suitable buoys, would furnish ships with supplies of water they are often in need of. M. Toselli appears to have studied the question carefully, and provided for the preservation of his apparatus in the face of storms.

The rapid melting of snow in the mountain regions causes great inundations in south-eastern France and in Switzerland, and Swiss papers daily record the damages done by the floods. The greatest damage is caused by the Doubs, both in France and Switzerland. The Rhine at Basel rose on February 16 by 6·22 metres, reaching thus a level only 2·46 metres lower than during the great inundation of March 1, 1876. Prof. Forel writes to the *Gazette* of Lausanne, that the level of the Lake of Geneva rose on February 15 and 16 at the rate of three millimetres hourly, or 155 millimetres in the course of two days, and he points out that more rapid risings were noticed only three times in the course of the last twenty-nine years (in 1856, and twice in 1876), when the level rose daily 73 to 82 millim. in twenty-four hours. The amount of water accumulated in the lake was thus as large as 42,000,000 cubic metres in the course of a day. The Lake of Zurich rose at the same time 40 centimetres in twenty-four hours; but its superficies being seven times less than that of the Lake of Geneva, the figure shows a far less accumulation of water, viz. of 26,000,000 cubic metres in the course of a day.

As one of the Memoirs of the Geological Survey, Mr. Whitaker has just published a paper on the Geology of the Eastern End of Essex (Walton Naze and Harwich). Longmans and Stanford are the publishers.

We are glad to hear that an ethnographical museum was opened at Helsingfors on January 24. The nucleus of the museum was formed from collections exhibited at the recent Helsingfors Exhibition. It contains a large number of clothed figures representing the varied ethnographical types of Finland and their yet more varied costumes, interiors of peasant's homes, samples of household furniture and tools, of hunting and fishing implements, of objects used by the yet numerous conjurors, collections of stone implements, &c. The importance of the museum will be well appreciated by all acquainted with the interest afforded by the ethnography of Finland.

The French Anthropological Society has been authorised by M. Krantz to open an international exhibition in the central palace of the Trocadero. M. Quatrefages has been appointed Chairman of the Commission. Communications relating to the exhibition may be sent either to the Society in Paris or to M. Gabriel de Mortillet, at the Musée des Antiquités Nationales, St. Germain, Seine-et-Oise. The Anthropological Exhibition will be distributed into a number of sections, and several national committees might be established if necessary. Further details will soon be published for the guidance of intending exhibitors or visitors.

On February 25 the city authorities of Vienna inaugurated a novel and remarkably interesting application of pneumatic tubes for the purpose of maintaining unison and regularity in widely-separated time-pieces. The inventor is the Austrian engineer and electrician, E. A. Mayrhofer, who, after vainly trying to solve the problem by means of electricity, finally hit upon the new system. From a central bureau in the city, connected with the Imperial Observatory, these pneumatic tubes extend in all directions, laid alongside the gas mains, and branching off to the public clocks. By means of a simple apparatus in the latter the authorities in this bureau are able to exhibit the true astronomical time on the clock dials in all parts of the city, a movement of the hands occurring once a minute. At present only the city clocks have been brought in connection with the new system, but it will rapidly be extended, until it embraces the time-pieces in all the schools, public institutions, hotels, &c., and in those private residences where it may be desired.

The prospects of coffee-cultivation in Coorg seem to be somewhat gloomy, for we learn from a recent report that the plants have not only had to contend with the regular insect and fungoid diseases, but also with such an extremely dry season, that the drainage of the country became very low, and all the springs and wells nearly exhausted. Many of the coffee nurseries had to rely on hand watering from springs and rivulets, and thousands of seedling plants constantly withered and dried up. The greatest damage, however, seems to have been done by what is described as "the planter's old and implacable enemy, the *Xylotrechus quadrupes*," commonly called the borer, the ravages of which are as destructive and extensive as ever; planters are often deceived as to the presence of this insect, the appearance of the trees even when attacked, failing to convey an idea other than health. The revelation at crop time, however, convinces the sceptic of the insidious approaches and devastations of the enemy, which can be overcome and subdued only by timely and resolute extermination of every bored coffee tree. The periodical increase of the insects is attributed by residents on or near the plantation to the prevalence of dry seasons. It spreads most in open coffee fields in warm localities, and least in moist and shady places where there is high cultivation. With regard to the *Hemileia vastatrix*, or leaf disease, it seems to have considerably lessened, or, as the report says, disappeared. This is almost more than we can expect, and as much as we can hope for; nevertheless, it may be as the writer of the report says, that the disease is existing under another form, "And may reappear in those well-known orange-coloured spots, for like other fungi it undergoes certain transformations. It is singular that these orange-coloured spores are generally encircling the stomata of the lower epidermis of the leaves, and," the writer proceeds to say, "I have found them even on leaves of coffee-seedlings not one year old. It is difficult to conceive how these spores should have come there, whether from without or within, the whole of the cellular tissue around the spots being affected as by an in-

ternal disease. It seems equally difficult to say, whether the fungus is the cause or effect of the diseased leaf. As to remedies, these appear to be expected rather from climatic influences than from the sagacity of man, for all the propositions yet made may prove satisfactory in the laboratory, but are impracticable where any large area is to be operated upon."

THE subject of blight or disease affecting the plants in the tea plantations of India has been brought prominently under the notice of the Agri-Horticultural Society of India, a letter having been addressed to the society to the effect that the attacks of "blight and red spider having become of such a serious nature on many tea-gardens both in Assam and Cachar, but especially in the latter province, it is necessary that all possible information, with a view of mitigating the evil, should be obtained and made widely known." At a subsequent meeting of the society the line of action proposed, subject to the assistance of those interested in the matter, was to engage the services of an entomologist from England for the period of two years so that he might have time and opportunities to observe and carefully study the character of the several kinds of blight in their various localities, such observations to be published under the auspices of the society.

THE introduction of the Carob (*Ceratonia Siliqua*) into the Madras Presidency, a subject which occupied the attention of the Agri-Horticultural Society of Madras a few years since, has been again brought before the society. It is strongly recommended for cultivation in countries suffering from periodical droughts in consequence of its long roots penetrating a great depth into the earth, and because of the large quantity of mucilaginous saccharine matter contained in the pods, so that it might be largely used for feeding cattle, horses, pigs, &c. It is said, however, that although the seeds contain nitrogenous elements or flesh-making materials, they do not possess great nutritive properties, and the seeds being small and hard they are not easily masticated, and pass in their crude state undigested.

A PECULIAR request (according to the *Berliner Tageblatt*) has been made by the Society for Bird Protection to the General Postmaster in Berlin, viz., to make arrangements so that birds be not killed by the pneumatic post. The case is this: From the large air-compressing steam-engines proceed chimney-pipes to the roof, by which the required air is sucked in. The power of this suction-apparatus is so great, that both small and large birds, even pigeons, which happen to be flying over the tubes when the engine is in action, are helplessly drawn in and destroyed.

TAKING opportunity, lately, to observe with a Nicol's prism an uncommonly fine rainbow, which spanned the Oesthal in Baden Baden, M. Schiel found that with the prism in a certain position, the colours disappeared completely, and the prism was pretty dark. But on turning it through 90°, the bow appeared again in all its brilliancy. The rainbow is therefore perfectly polarised light. Several rainbows observed since have shown the same behaviour; but apparently only a very bright-coloured rainbow presents dark on the field of vision with the corresponding position of the prism.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Thos. Dalby; a Galapagan Tortoise (*Testudo elephantopus*) from the Galapagos Isles, presented by Mr. W. H. Henderson; two Herring Gulls (*Larus argentatus*), European, deposited; a Common Nuthatch (*Sitta cæsia*), European, purchased; a Red Kangaroo (*Macropus rufus*), born in the Gardens.

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie. Ergänzung Band viii., Stück 2.—Researches on the nature of the vowel "clang," by M. Auerbach.—On the interference of reflected light (concluded), by M. Lommel.—On the tension of liquid films, by M. Sondhauss.—On a fundamental law in dioptrics, by M. Most.—On the complementary colours of gypsum in polarised light, by M. v. Kobell.

Memoria della Società degli Spettroscopisti Italiani, November, 1876.—The paper by Prof. Young, of Dartmouth College, on the displacement of the lines in the solar spectrum caused by the sun's rotation appears here. Prof. Young used the spectra of the sixth and eighth orders obtained by a grating of 8,640 lines to the inch, a collimator of 2¼ inches diameter, and 16 inches focal length attached to the 9¼ inch equatorial. The observations were made chiefly on the D lines and the Ni line between them giving a result of 1·42 mile a second; this exceeds the result from ordinary observations of spots by 0·34 mile, and the author considers it a fact that the solar atmosphere really sweeps on forward over the underlying surface.—Prof. Tacchini gives a history of his journey up Mount Etna for the purpose of making spectroscopic observations of the sun. The spectroscopic and direct observations of the sun made at Palermo in October last appear here, also the drawings of the chromosphere for May, 1875.

December, 1876.—Father Secchi gives his catalogue of 444 coloured stars with notes on the spectra of the same.—Mr. Huggins contributes a preliminary note on the photography of stellar spectra, together with a drawing of the spectrum of α Lyræ.—Observations of the lunar eclipse of September 3, 1876, by A. Dorna.—Observation of the Perseids made at Palermo in August, 1876, by Prof. Tacchini and G. de Lisa.

Morphologisches Jahrbuch, vol. ii. part 4.—On fossil vertebræ and teeth, by C. Hasse, dealing especially with fossil squatinas from the Jurassic and Cretaceous rocks.—On the development of the auriculo-ventricular valves of the heart, by A. C. Bernays. —On the segmentation of the ovum and formation of the blastoderm in Calyptræa, by A. Stecker.—On the primitive groove in the chick, by A. Rauber.—On the nasal cavities and nasal duct of Amphibia, by G. Born, seventy pages, three plates.

Revue des Sciences Naturelles, vol. v., No. 3, December, 1876.—Contributions to the natural history and anatomy of the Ephemeridæ, by N. and E. Joly, an important paper.—On parthenogenesis in *Bombyx mori*, by Carlo de Siebold.—On the histology of the egg, by A. Villot, dealing with theoretical views on the germinal vesicle and its history. There are also excellent reviews of recent French zoology, botany, and geology.

Zeitschrift für wissenschaftliche Zoologie, vol. xxvii., part 4, 1876.—On the anatomy of the Ophiuroid, *Ophiactis virens*, by H. Simroth, seventy pages, five plates.—On the structure of the brain in Arthropods, a memoir describing the brains of *Apis mellifica, Gryllus campestris, Gryllotalpa vulgaris, Carabus viol.*, and *Astacus fluviatilis*, by M. J. Dietl, of Innsbruck, thirty pages, three plates.—On the transformation of the Mexican Axolotl into Amblystoma, by Marie v. Chauvin.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. x. fasc. 1.—On Arabic money in the numismatic cabinet of Milan, by M. Ghiron.—On the coordinates of points and of lines in a plane, and of points and planes in space, by M. Casorati.—On two meteorological instruments invented by Angelo Bellani, by M. Cantoni.—On special cases of anencephaly, with observations on their etiology, by M. Sangalli.—On *Helminthosporium vitis* (Lev), a parasite of the leaves of the vine, by M. Pirotta.—On the phenomena which accompany the expansion of liquid drops, by M. Cintolesi.

Journal de Physique, February.—On a property of an electrified surface of water, and on the polarisation of the electrodes, by M. Lippmann.—On the phenomena of induction (concluded), by M. Mouton.—Comparative pitches of sounds given by various metals and alloys, by M. Decharme.—Experiments of M. Ch. Lootens, S.I.—The movements of the aërial column in sonorous tubes, by M. van Tricht, S.I.—The electric properties of sodium and potassium at different temperatures, by MM. Naccari and Bellati.

SOCIETIES AND ACADEMIES

London

Royal Society, February 8.—"On the Hindoo Division of the Octave, with some Additions to the Theory of the Higher Orders," by R. H. M. Bosanquet, Fellow of St. John's College, Oxford. Communicated by Prof. Henry J. S. Smith, Savilian Professor of Geometry in the University of Oxford.

Attention has been recently directed to the remarkable division of the octave into 22 intervals, employed by the Hindoos. The paper commences with a slight account of the Hindoo scales as thus derived. It is then remarked that our best way to a real analysis of this music would be to study the system of 22 and compare the results with those actually obtained by Hindoo musicians. The methods, which have been employed in the writer's former paper on the subject,[1] are then extended to the higher orders, which have not been before thoroughly discussed. The system of 22 is a system of the second order, and the nature and peculiarities of such systems, and of the system of 22 in particular, are discussed.

A classification of systems of the higher orders according to their mode of forming thirds is advanced. If the system be arranged in successive series of fifths, differing by one unit in pitch, then the system is said to be of class x, if the third of any note is in the series x units below that which contains the note itself.

The system of 22 is shown to be of the second order and first class.

A system of 34, also of the second order and first class, is pointed out as being of considerable excellence, even from a modern practical point of view.

It is shown that in systems of the second order and first class, modulation through a third cannot be regarded as equivalent to modulation through any number of fifths.

The notation is extended to systems of the rth order.

The subject of the transformations of the generalised key-board is then entered upon. It is remarked, in the first instance, that any form of arrangement whatever can be constructed by rearranging a supply of keys of the ordinary patterns.

The problem of inversion is then solved, and it is shown under what circumstances, by simply inverting the succession from end to end, a key-board can be obtained in which rise corresponds to fall of pitch, and *vice versâ*.

The general transformation of the rth order is then investigated, and a rule is given by which the key-board of the rth order can be arranged with the ordinary keys.

This rule is then applied to the construction of the key-board of the second order, and a diagram is given of a portion of a key-board so arranged. Systems of the second order and first class, such as the systems of 22 and 34 above-mentioned, can be controlled with facility by means of this arrangement.

February 15.—On Crookes's force, by G. Johnstone Stoney, F.R.S., and Richard J. Moss, F.C.S.—This paper is a preliminary report of an experimental investigation of the theory of Crookes's radiometer proposed by Mr. Stoney in the *Philosophical Magazine* for March and April, 1876. The term "Crookes's force" is employed to designate the reaction which comes into play between the blackened disks of a radiometer and the walls of the exhausted chamber when a difference of temperature exists between them. The authors have sought to determine quantitatively the relation of the force to the tension of the residual gas, and the influence of variations in the distance between the reacting surfaces. For this purpose they employ an apparatus in which a blackened disk of pith can be placed at any required distance within twelve centimetres from a delicately suspended disk of thin microscope glass. The pith disk is heated by projecting on it the image of a uniformly illuminated aperture in a metallic screen. The relative magnitudes of the force are estimated by determining the distance to which the glass disk is repelled in a given time. It is sometimes difficult to distinguish between the effects of convection currents and those of Crookes's force. It is certain, however, that when the tension of the residual gas is as much as five millimetres of mercury there is a Crookes's reaction through a space of at least ten millimetres.

At distances of from twenty to eighty millimetres the very feeble force acting on the glass disk seemed to vary about inversely as the tension. It appeared to be nearly independent of the distance when the distance exceeded twenty millimetres.

[1] *Proc. Roy. Soc.*, No. 161, 1875, p. 390, and "An Elementary Treatise on Musical Intervals and Temperament." (Macmillan, 1876.)

At distances of five, ten, and twenty millimetres, the force on the swinging disk made some approach to varying at each tension inversely as the distance. But so far as may be judged from measures of such exceedingly feeble forces, there is a sensible deviation from this law at most of the tensions. Moreover the observations, taken as a whole, seem to suggest, in conformity with the dynamical theory, that the law changes with variations of density.

Linnean Society, February 15.—Prof. Allman, F.R.S., president, in the chair.—Messrs. W. Burns, E. L. Gardner, Prof. W. Harrington (of Michigan, University, U.S.), J. W. S. Meiklejohn, the Rev. J. Stobbs, and Sir Charles W. Strickland, Bart., were elected Fellows.—There was exhibited under the microscope by Mr. Arthur Lister the plasmodium of one of the lowly organised Myxomycetæ. This protoplasmic mass demonstrated the peculiar amœboid movements, and the occasion gave rise to an animated discussion on its contested animal or vegetable nature.—Two botanical papers were read, the first on the rootstock of *Marattia fraxinea*, Sm., by Mr. John Buchanan; the second on the Algæ collected at Rodriguez during the Venus Transit Expedition, 1874, by Prof. Dickie. The Marattia is chiefly found in the northern part of New Zealand. The Maories use it as food, but do not cultivate it systematically. They say that when it is smashed, the pieces thrown on the ground spring up freely and thus it has increased. At Wellington, where transplanted, it grows luxuriantly when placed in rich damp soil. Mr. Buchanan has now studied its mode of growth; he considers the rootstock as resembling a scaly bulb more than a fern rhizome, and likens its propagation to that of the potato, though modified. Its growth is very slow, hence, probably, its scarcity. The fresh-water Algæ of Rodriguez point in an Asiatic direction, none are African species, while some have rather a world-wide distribution.—The Secretary read a note on a new example of the Phyllodocidæ (*Anaitis rosea*), by Dr. W. C. McIntosh. This marine worm was obtained at St. Andrews. It is $1\frac{1}{2}$ inch long, with relatively broadish body, blunt snout, and small eyes. On head and body it is slashed and speckled with pink, which merges into a yellow band behind.—A communication was read on deep-sea anemones (Actinaria) dredged from on board the *Challenger*, with a description of certain Pelagic surface swimming species, by Mr. H. N. Moseley, late naturalist to the above expedition. The occurrence at great depths of representatives of ordinary shallow water forms of Actinia is of profound interest. A species of Edwardsia, from 600 fathoms, has undergone but trifling modification from the littoral form. The *Cerianthus*, from 2,750 fathoms, is dwarfed, but uncommonly like its shore brethren. Thus it appears one kind is found in shallow water at the Philippines under the full glare of the tropical sun, while another species of the same genus exists at three miles depth, where solar rays never penetrate, and the water keeps at freezing point. The fact of the deep-sea-Anemones retaining vivid colouring in their dark watery abode is a point of special value as connected with certain other generalisations. The new genus *Corallinomorphus* likewise possesses interest both on account of being a near ally to certain of the simple discoid corals, and of its having the largest stinging cells (nematocysts) yet recorded.—An extract of a letter on the marsupial pouch of the Bandicoot, by Mr. R. D. Fitzgerald, was briefly adverted to by the Secretary.

Chemical Society, March 1.—Prof. Abel, F.R.S., president, in the chair. Prof. E. T. Thorpe delivered his lecture on "The theory of the Bunsen lamp." The speaker, after some preliminary remarks as to the great value of this instrument, both to the scientific chemist and also in the arts, gave a short description of the lamp and proceeded to show the principle on which it acted. The gas issuing from the jet draws in air through the holes in the side, and becomes mixed with it in the tube, the amount of air being about 2 to $2\frac{1}{2}$ times the volume of the gas, and as it burns on an average 80 litres of gas per hour, as much as 250 litres of the mixed gases pass through the tube of the lamp in that space of time. After having sketched the progress of the mixture of gas and air up the tube, attention was directed to the flame itself, which is hollow, and contains a large internal space of the uninflamed gaseous mixture. As it has been found that a mixture of gas with less than $3\frac{1}{2}$ times its volume of air will not burn, it is only, therefore, when it meets with an additional supply of oxygen from the surrounding air that combustion occurs. The composition of the gas in the tube and in various parts of the flame was then studied, and the probable causes of the want of luminosity in the flame stated these are due

to the dilution of the gas by the nitrogen, the oxidation of luminiferous material, and the depression of temperature produced by the diluting gases, such as nitrogen, carbonic oxide, and aqueous vapour.

Meteorological Society, February 21.—Mr. H. S. Eaton, M.A., president, in the chair.—William Adams, Thomas Black, Robert W. Munro, and R. Bowie Wallcott, M.D, were elected Fellows; and Mons. U. J. Leverrier, Director of the Observatoire National, Paris, an honorary member of the society.—The President gave an inaugural address. After referring to the various theories advanced to account for changes of climate, he observed that in drawing deductions from a long series of observations of the temperature of the air, it is important to ascertain whether the conditions of the surrounding district have altered, otherwise changes in reality due to local causes may be erroneously assigned to secular variation. The climate of London has thus been modified by the consumption of fuel and the vast population. He estimated that the heat developed from the present annual consumption of 5,000,000 tons of coal on the metropolitan registration area of 118 square miles, and from all other artificial sources, would suffice to raise the temperature of a stratum of air 100 feet in depth resting on that area $2^{\circ}\cdot 5$ every hour. The effect of the growth of the population of London from 900,000 at the commencement of the century to 3,500,000 at the present time, and of the still greater increase in the comparative consumption of coal was manifested by the rise in the average temperature of the air at the Royal Observatory, Greenwich, which place was year by year becoming more surrounded by a network of houses and population. For this reason Greenwich was not a suitable place for a Meteorological Observatory of the first order. Mr. Eaton subsequently referred to some of the practical difficulties experienced in pursuing the study of dynamical meteorology.—The following papers were then read:—Barometrical and thermometrical clocks for registering mean atmospheric pressure and temperature, by William F. Stanley; solar thermoradiometer; and on an improvement in minimum thermometers for terrestrial radiation, by James J. Hicks.

Anthropological Institute, February 27.—Mr. John Evans, F.R.S., president, in the chair.—Mr. A. H. Keihl, was elected a member.—Mr. M. J. Walhouse read a paper on non-sepulchral rude stone monuments. Adverting to the extravagant Druidical and Dracontian theories formerly connected with megalithic remains, he observed that perhaps at present speculation had gone to another extreme in refusing to see in them any purposes other than sepulchral. In this paper he adduced examples, many from his own observation of cairns, cromlechs, torlithons, stone-circles, and other megaliths, which he considered could not have been connected with burials, and he advocated the non-sepulchral intention of open-sided dolmens such as Kitscoty House, and those at Rollright and Drewsteignton, comparing them with similar structures now used in India as rude temples for sacred stones and images. The paper concluded with some observations on stone-worship, especially as now practised in India. Many existing instances were described, and passages quoted from classic authors, denoting its prevalence in antiquity. Some speculations were also brought forward as to the causes of rough stones having been so frequently taken for objects of worship. Col. A. Lane Fox, Mr. Hyde Clarke, the President, and others, took part in the discussion.

Entomological Society, January 17.—Anniversary Meeting —Sir Sidney Smith Saunders, C.M.G., vice-president, in the chair.—An abstract of the treasurer's account and the Report of the Council for 1876 were read.—The following were elected members of council, viz., Prof. Westwood, Sir Sidney S. Saunders, and Messrs. H. W. Bates, Champion, Dunning, Grut, Meldola, Stainton, Weir, Douglas, E. Saunders, Rev. A. E. Eaton, and Rev. T. A. Marshall.—The following officers were elected, viz., Prof. Westwood, president, J. Jenner Weir, treasurer, Rev. T. A. Marshall, librarian, and Messrs. F. Grut and R. Meldola, secretaries.—The president, in consequence of an accident, was prevented from attending, and the delivery of his address was unavoidably postponed till the next meeting.

February 7.—Prof. Westwood, president, in the chair.—W. Denison Roebuck, of Leeds, was balloted for and elected a subscriber.—The president nominated Messrs. J. W. Douglas, J. W. Dunning, and H. T. Stainton as vice-presidents for the ensuing year.—The president delivered the address, postponed from the last meeting, on the progress of entomology during the past year. —Mr. F. Bond exhibited a specimen of the North American utterfly, *Danais Archippus*, taken in September last near Hassock's Gate, Sussex, being the third specimen taken in this country. —The president exhibited a specimen of the singular butterfly *Bhutanitis Lidderdalii*, Atkinson, from Bhotan. He also read a letter which he had received from Baron v. Osten Sacken referring to his paper on the Dipterous genus *Systropus*, published in the last part of the *Transactions* of the Society, in which he had stated that a species in Natal (*S. crudelis*) had been bred from a cocoon resembling that of *Limacodes*, and pointing out that *Systropus macer*, the common species in the United States, had been bred from the cocoon of *Limacodes hyalinus*, and was a remarkable instance of community of habit among insects of the same genus in far-distant regions.—The president read some remarks he had received from M. Ernest Olivier, of Moulins, respecting insects of the Dipterous genus *Bombylius*, frequenting the nests of a bee of the genus *Anthophora*, at Pompeii.—Mr. McLachlan exhibited a case of a Lepidopterous larva sent by Dr. Kirk, of Zanzibar, who had found it on a species of *Mimosa*. He considered it to be allied to *Psyche* and *Oiketicus*; and it was remarkable on account of its form, which bore a striking resemblance to that of a flattened *Helix*. It appeared to be constructed of a substance resembling *papier maché*, with a smooth, whitish, external coating.—Mr. C. O. Waterhouse exhibited some remarkable varieties of British Lepidoptera, viz., *Chrysophanus phlœas*, *Polyommatus Adonis*, *P. Alexis*, and *Agrotis exclamationis*.—Dr. Buchanan White forwarded an extract from the *Medical Examiner* of December 21 last, containing an account by Dr. Tilbury Fox of an extraordinary case of "Pruritus," which afflicted every member of a family and household, including even the dog and cat. A specimen of the insect causing it had been submitted to Dr. Cobbold, who had pronounced it to be a species of *Trombidium*, which was believed by Dr. Fox to have originated from certain plants in the garden, and that the cat and dog which appeared to have been the first affected, were agents in conveying the parasites to the human members.—The following papers were read, viz.:—Notes on the African *Saturnidæ* in the collection of the Royal Dublin Society, by W. F. Kirby.—Descriptions of new genera and species of Phytophagous beetles belonging to the family *Cryptocephalidæ*, together with diagnoses and remarks on previously-described genera, by Joseph S. Baly.—Descriptions of new species of Phytophagous beetles belonging to the family *Eumolpidæ*, including a monograph of the genus *Eumolpus*, by Joseph S. Baly.

Physical Society, February 17.—Prof. W. G. Adams, vice-president, in the chair.—Mr. T. W. Philips, C.E., was elected a member of the society.—Prof. Guthrie exhibited, for Mr. C. J. Woodward, an apparatus he has devised for showing to an audience the interference of transverse waves. A light frame, capable of moving in a vertical plane, carries a horizontal strip of tin about two feet in length, cut in the form of the ordinary sine wave, and which supports, by means of a roller, a light wooden block carrying an ink recorder in front of a sheet of paper. This block slides in a vertical slot in a piece of wood, which can be moved horizontally, supported by a roller on another similar strip of tin fixed parallel to the first, and vertically below it. The movable frame rests on a castor attached to this block. If the relative positions of the waves be now varied, and the blocks moved along them, the path traced by the ink recorder will represent the wave due to their combination.—Mr. S. P. Thompson exhibited some galvanometers in the form of magic-lantern slides which he has arranged for exhibiting their indications to an audience. The instruments are, however, only capable of indicating comparatively powerful currents, and he hopes to succeed in arranging forms of greater sensitiveness. The index-needle is usually formed of cardboard, and two small steel needles are attached to it parallel to its axis. It is pivoted lightly between glass plates, and influenced by the current traversing coils of wire placed beyond the circle in which it rotates. The best effects were obtained by means of two curved electro-magnets surrounding a small steel magnet, but this form is inapplicable to quantitative determinations, on account of the residual magnetism of the iron cores. A gold leaf electroscope formed on this principle was capable of detecting very small charges of statical electricity.—Mr. Wilson then showed an arrangement for exhibiting convection-currents in heated water. It consists of a small glass cell with parallel sides. In the base of the wood dividing the sides is cut a slight depression, to expose a brass tube which traverses it horizontally, and is open at one end, while the other is bent at right angles and connected with a flask containing water. The brass tube, where it is exposed in the cell, is surrounded with a jelly formed of gelatine containing rose aniline,

and the cell is filled with water and projected on the screen. When the tube is heated by boiling the water in the flask, the jelly is liquefied, and the liberated colouring-matter rises in the water, showing the direction of the heated current.—Prof. Guthrie exhibited an arrangement he has been using, with a view to determine the vapour-tension of water, and explained the difficulties to which such a determination is liable, and the manner in which his apparatus has so far failed. It was shown that a crystal of alum or a saturated solution of salt, when introduced into the Torricellian vacuum, depresses the mercurial column less than pure water, whereas a solution of size, gum arabic, or any colloid, depresses it to precisely the same extent. It thus appears that water in its different states of combination has different vapour densities, and their determination requires an arrangement in which the several substances can be easily introduced into the Torricellian vacuum, and very slight changes of the level of the mercurial column can be ascertained. Prof. Guthrie has been employing a U-tube thirty-three inches long, one extremity of which is bent, and terminates in a capillary opening, and a bulb is formed at the U-bend. If the substance under examination be introduced at the open end after the apparatus has been filled with mercury, inverted and the superfluous metal escaped, the mercury expelled through the capillary opening will give a measure of the amount of the depression.—Prof. McLeod suggested a modification of this form of apparatus.—Prof. Guthrie then showed the manner in which electricity is distributed on non-conductors, such as the plate of an electrophorus, by placing it for a given time beneath a point connected with a charged Leyden jar, and subsequently sprinkling a mixture of sulphur and litharge over it. It was shown that the diameter of the circle formed below the point after the superfluous powder had been removed is not purely a function of the distance between the point and the plate, but is mainly influenced by the conductivity of the material, and further, that if the point be directed obliquely towards the plate, the circle formed is very slightly eliptical, but the elipticity is in no degree proportionate to the obliquity of the point; and finally, he showed that if the non-conducting plate of an electrophorus be written upon with a metal and sprinkled with the above mixture of sulphur and litharge, the former or latter adheres according to the nature of the metal used, and he suggested that some such arrangement might be employed as a kind of electrical touchstone for discriminating between certain metals.

EDINBURGH

Royal Physical Society, February 21.—R. H. Traquair, M.D., president, in the chair.—A paper was read by Dr. Traquair, on the structure of the lower jaw in *Rhizodopsis* and *Rhizodus*. He stated that he had ascertained that the detached bone hitherto considered to be the premaxilla of *Rhizodopsis* was in reality the dentary element of the lower jaw. This bone shows one large laniary tooth at its anterior extremity, behind which the margin is set with a series of small teeth of uniform size. Complete specimens of the mandible of *Rhizodopsis* show, however, besides the large tooth in front, several others placed at intervals behind it, and internal to the range of small teeth. The question was, therefore, what had become of these other laniaries in cases where the dentary bone was found detached. An explanation of this was afforded by an investigation into the structure of the lower jaw in the closely-allied *Rhizodus*. In this gigantic form the dentary element of the mandible is conformed just as in *Rhizodopsis*, bearing one large tooth in front, the rest of the margin being occupied only by smaller ones, the remaining laniary teeth being borne by separate internal dentary pieces articulated to the inner side of the dentary proper, and of course liable to be dispersed and lost in cases where the elements of the lower jaw had become detached from each other before their entombment as fossils. Analogous accessory bones bearing the large teeth of the lower jaw had previously been known to exist in the dendrodont fishes of the Old Red Sandstone. As regards the true premaxilla of *Rhizodopsis*, it was ascertained by Dr. Traquair to be a very small bone articulated to the front of the cranial shield as in other fossil fishes of the same group. Papers were read (1) on the ornithology of Yedo, by Colin A. McVean, and (2) on the occurrence of the Black Redstart (*Ruticilla tithys*) in Stirlingshire, by J. A. Harvie Brown.

BERLIN

German Chemical Society, February 12.—A. W. Hofmann, vice-president, in the chair.—A. Wüllner states that an observation lately published by F. Müller, that steam raises the temperature of saline solutions above 100°, was known before the time of Gay-Lussac, and is in no way opposed to the fact that the steam evolved from saline solutions has the temperature of the latter, as observed by the late G. Magnus and himself.—C. Hensgen continuing his researches on the action of hydrochloric acid on sulphates, has observed the transformation of blue vitriol and of sulphate of magnesia into chlorides at a red heat.—M. Conrad and W. R. Hodgkinson have found that the action of sodium on acetate of benzyle engenders benzyl-acetate of benzyl, that is hydrocinnamate (phenyl-propionate) of benzyl :—

$$\begin{array}{ccccccc} CH_3 & & & & CH_3 & & \\ \vert & + & Na & = & \vert & + & C_7H_7 \\ CO_2C_7H_7 & & & & CO_2Na & & \\ \text{Acetate of benzyl.} & & & & \text{Acetate of sodium.} & & \text{Benzyl.} \end{array}$$

$$\begin{array}{ccccccc} CH_3 & & & & CH_2C_7H_7 & & \\ \vert & + & C_7H_7 & = & \vert & + & H \\ CO_2C_7H_7 & & & & CO_2C_7H_7 & & \end{array}$$

Benzylacetate (or phenyl propionate) of benzyl.

E. Chambon states that bromine transforms fuchsine into tetrabrominated rosaniline-bromhydrate $C_{10}H_{15}Br_4N_3.HBr$, a fact already known through the researches of Caro and Gräbe.—T. Iobst and O. Hesse describe several constituents of coto bark: *paracotoin* $C_{19}H_{12}O_6$, transformed by barytes into paracotoinic acid $C_{19}H_{14}O_7$, and by potash into paracumarhydrine :—

$$C_{19}H_{12}O_6 + 2H_2O = CO_2 + \underset{\text{Para-cumarhydrine.}}{2C_9H_8O_3}$$

This losing water easily yields $C_9H_6O_2$ paracumarin. They also describe hydrocotoin $C_{22}H_{20}O_6$, Cotoin $C_{22}H_{18}O_6$, cotonetin $C_{20}H_{16}O_5$, oxyleucotin $C_{21}H_{20}O_7$, leucotin $C_{21}H_{20}O_6$.—H. Beckurts and R. Otto prefer sulphuric acid to alkali for transforming propionitril into propionic acid. They consider solid dichloropropionitril to be polymeric with the liquid substance. They likewise describe dichloropropionic acid and its transformation into monochloracrylic and pyroracemic acid.—C. A. Martius gives a detailed description of the production and refining of petroleum in Pennsylvania.

February 26.—A. W. Hofmann, vice-president, in the chair.—A. Christomanos published the result of a great number of analyses of Greek chrome-iron-ore leading up to the formula of R_3O_4 with varying amounts of CaO, MgO, SiO, &c. The proportion of Cr_2O_3 and FeO varies between 1 : 2, 2 : 3, 1 : 1, and 3 : 2.—From researches by K. Heumann, it appears that the greenish powder resulting from the action of nitrate of silver on ultramarine (discovered by Unger) is a mixture. The chief ingredient is yellow, but it has not been analysed.—J. H. Droeze has determined the solubility of sulphate of lime in water at various temperatures and in solutions of various salts.—T. Moddermann published speculations on atomicity.—V. Meyer denied the correctness of Ladenburg's experiments and his conclusions as to the difference of $N(C_2H_5)_3C_7H_7I$ and $N.(C_2H_5)_2 . C_7H_7 . C_2H_5I$.—Br. Radziszewsky communicated that the following bodies show phosphorescence under he oxidising influence of alcoholic potash: paraldehyde, metaldehyde, aldehyde-ammonia: furfurin, hydrocinnamide, hydrocuminamide, hydranisamide, anisidin; formic aldehyde. The author calls attention to the observation of Duchenim, that noctiluca miliaris acts on the skin like nettles, which have been proved to contain formic acid. He thinks that noctilucæ may contain formic aldehyde.—R. Auschütz has found that chloride of acetyl transforms bibasic acids, viz., succinic, phthalic, and diphenyl-dicarbonic acids into anhydrides, being itself transformed into acetic acid. The same chemist, conjointly with R. Schultz, has tranformed phenanthrenchinone into diphenyl-dicarbonic acid by the action of sodium amalgam by simultaneous reduction and oxidation :—

$$\begin{array}{ccc} C_6H_4\text{—}C{=}O & C_6H_4\text{—}CH\,.\,OH & C_6H_4\,.\,COOH \\ \vert \qquad\quad \vert & \vert \qquad\quad \vert & \vert \\ C_6H_4\text{—}C{=}O & C_6H_4\text{—}CH\,.\,OH & C_6H_4\,.\,COOH \\ \text{Phenanthren-chinone.} & \text{Unknown alcohol.} & \text{Diphenyl-dicarbonic acid.} \end{array}$$

E. Hartwig published preliminary remarks on phthalic aldehyde. —H. Limpricht has found that hydrochloric acid transforms sulphonic acids into the corresponding hydrocarbons :—

$$C_6H_5SO_3H + HCl = C_6H_6(+ SO_3Cl?).$$

O. N. Witt, in a note on the history of chrysoidine, claims for himself the discovery of this colouring-matter, while he acknowledges that H. Caro has likewise prepared this substance by an independent discovery.—A. Baeyer has prepared from furfurol, $C_4H_3O . COH$, and acetic anhydride, a new acid :—

$$C_4H_3O . CH = CH . COOH,$$

a furfuryl-acrylic acid, yielding a green colouring-matter with phenol. With propionic anhydride a homologue is obtained.—

H. Schwartz has studied the bromides and chlorides of chlorinated anthracene and their action on potash.—Arno Behr, chemist to the large sugar-refinery of Messrs. Matthiessen and Wichers in Jersey city, has found in the residues of cane-sugar aconitic acid, while citric acid is one of the regular ingredients of beet-root.—A. W. Hofmann after showing a circular table of chemical reactions designed by Dennis Monnier in Geneva, returned to the statement of Kern that mono-methyl-aniline, formerly described by the speaker, does not exist, and read a paper by F. Hepp, who described mono-methyl-aniline obtained from sodium-aceto-methyl-aniline, with the same properties formerly described by himself. Hofmann has obtained the same body by the action of chloride of ethyl on aniline.

GENEVA

Physical and Natural History Society, December 7, 1876.—M. Théod. Turrettini presented a specimen of a diplographe, or writing machine for the blind, constructed at his workshop. The apparatus is the invention of M. Ernest Recordon, and prints at once for the blind according to one of the systems in use for them, and for the seeing in ordinary characters.—M. Th. Turrettini explained the method devised by M. Raoul Pictet and himself, to obviate the opacity of the ice obtained by the machine of M. Pictet. The opacity of the ice thus manufactured results from the rapidity of the freezing of the water, which does not permit the air contained in the liquid to escape during its change of state. By retarding considerably this freezing the ice obtained is transparent. We may thus obtain an almost complete transparency by expelling from the freezing water the air which it contains by the preliminary action on the water of a paddle-wheel agitating the liquid.—Mr. Duby presented a paper relating to eighteen species and one genus of new mosses from Japan, the Philippines, and Mauritius. A considerable number of mosses from Mauritius are also met with in the Sunda Islands.—M. Hermann Fol gave an account of observations made by him on the fecundation of eggs, especially of the sea-urchins. He has seen the zoosperm penetrate the vitellus and push a species of vesicule into the interior of the wall of the egg. Starred grooves show themselves soon after all over the vesicule. The latter then detaching itself from the wall begins to move, approaches a female nucleus, and combines with it so as to form only a single nucleus. At the two poles of this nucleus are formed two small masses of protoplasm, from which devolve starred grooves both in the interior and exterior of the nucleus. These polar masses enlarge, deviate more and more, then the cellular division takes place. In other animals the phenomenon is complicated, but may also be followed.

December 21, 1876.—Prof. Schiff gave a *résumé* of his researches on the electricity of the nerves for the purpose of examining the electric nature of the nervous agent, and determining whether the currents are produced in the nerves of living animals. He concludes that the normal nerve when the animal is in a state of immobility does not present any current. When a current manifests itself it results from the alteration of the death of the nerve such as is produced by section, or better still from nervous activity, and the contraction which accompanies it.

VIENNA

Imperial Academy of Sciences, December 7, 1876.—The following, among other papers, were read:—Contributions to a knowledge of the Bryozoa of the Bohemian Chalk formation; second part treating of the Cyclostomata, by M. Novak.—Studies on the geological origin and the progressive development of the North Albanian coast land, by M. Koncicky.—New observations on Geissler tubes, by M. Rosicky.—On the earthquake of Belluno on June 29, 1873, by M. Höfer.

December 14, 1876.—On the formation and integration of equations, which determine the molecular motion in gases, by M. Boltzmann.—On the nature of gas molecules, by the same.—On a remarkable property of periodic series, by M. Toepler.—On the methylic ether of resorcin, and on glycyrohizin, by M. Habemann.—On grape sugar, by MM. König and Rösenfel.

January 4, 1877.—On the origin of the posterior nerve-roots in the spinal cord of Ammocoetes (*Petromyzon planeri*), by M. Freud.—New methods for solution of indeterminate quadratic equations in whole numbers, by M. Kunerth.—On the amyloid substance in heart flesh, by M. Heschl.—On aperture widening muscles, by M. Exner. Longitudinal muscle-fibres in the wall of an animal tube; generally widen the tube when they contract.—Observations in November at the Meteorological Observatory, Vienna.

January 11.—On *Eunicicola Clausii*, a new parasite of annelides, by M. Kurz.—On the influence of methodical drinking of hot water on the course of *Diabetes mellitus*, by M. Sommer.—Remarks on some problems of the mechanical theory of heat, by M. Baltzmann.—On a general mode of determination of the foci of contours of surfaces of the second degree, by M. Pelz.—On the vessels of bones of the skull and the dura mater, by M. Langer.—Barometric observations in the western part of the Balkans and neighbouring regions, by M. Toula.

January 18.—On drainage and irrigation works in the valley of the Save, by the General Commando in Agram.—Astronomical and geodetic determinations of the Austro-Hungarian Polar Expedition, by M. Weyprecht.—On the theory of the Bessel functions, by M. Gegenbauer.—On the theory of the action of cylindrical spirals with variable number of windings, by M. Wallentin.—On a peculiar formation of isocyanphenyl, by MM. Cech and Schwebel.—On the arrangement, use, and accuracy of M. Roskiewicz's distance-measurer, by M. Schell.—On the development-history, and the structure of the seed-envelope in Phaseolus, by M. Haberlandt.

I. R. Geological Institute, December 5, 1876.—The following papers were read:—M. Karl v. Hauer on the analysis of the acid spring lately discovered at Ranigsdorff, near Mährisch-Trübau in Moravia. The water contains a very small quantity of fixed ingredients, but the abundance of free carbonic acid is equal to the well-known Giesshübel springs. 10,000 parts of water contain in weight 26 parts of free carbonic acid, so that the volume of the latter exceeds by far that of the former. The springs may therefore be considered of remarkable quality.—M. J. Gamper on diluvial vertebrates. At a little distance from the Klause at the Gahus Mountain near Gloggnitz, the author found a block of limestone covered by thin strata containing remains of vertebrate bones; in some places the layer formed a real breccia of bones. Among the remains he noted especially those of bats. The blocks formed a part of the inner wall of a cleft or cavern, like those often found in limestone mountains of this country. M. Gamper then referred to the occurrence of clay silicate near Steinbrück, and of arseno-pyrite in Joachimsthal.—M. Itache continued his communications on the eruptive rocks that he examined last summer in the mountainous regions of Upper Vintschgau, Ortler, and Veltlin, mentioning particularly the various species of tonalites from Morignone, the Gabbor rocks from Frontale and Leprese, and some little-known rocks containing many garnets. In the country of Soudalo and Boladore, light coloured pegmatites intersect in veins the dark coloured amphibolite and diorite rocks.—Dr. Tietze on the Elburs Mountains in Persia. He mentioned the relatively rare occurrence of old crystalline rocks in this mountain chain. The formations which may be determined by palæontological evidence are the Devonian, the Carboniferous Limestone, the Lias, the Upper Cretaceous, showing various facies partly abounding in fossils, the Nummulite formation, and the younger Tertiary. Other formations, containing no fossils, could only be judged by their position relative to those formations whose geological age was clearly to be determined. Almost certain is the occurrence of Trias and Upper Jura. The Lower and Middle Cretaceous are totally wanting. Only a few of the named formations extend over the whole country, therefore if two sections are made at some distance from each other, they give almost invariably a different result. M. Tietze gave also a short account of the older and younger eruptive rocks, of which these mountains are partly composed. The volcanic Demavend is not only the highest but also the youngest mountain of the whole chain, whose dimensions are given by the author as 90-100 miles in length, and at least fifteen miles in breadth.

January 23.—Dr. E. Tietze on the geological relations of the Demavend Mountain in Persia, whose height amounts to 20,000 feet. He distinguished an upper and a lower region, the former consisting of the cone heaped up by eruptions. The highest top of the cone, acting still as a solfatara, stands within the remains of an older crater-wall. The lower part is composed to a height of 9,000 feet of sedimentary rocks (Jurassic limestones, Carboniferous sandstones, and old limestone). It must be noted particularly that the position of these sedimentary strata shows exactly the same relations as those of rocks in other parts of the Elburs Mountains which are not in contact with volcanoes, a proof therefore that the outburst of the Demavend volcano exerted no influence upon the older rocks in its vicinity. The reporter mentioned the occurrence of streams consisting of lava-boulders on the Demavend, as they are found at present on the volcanoes of Java; then of columnar trachytes and of the lava streams keeping their original position, but

steeply inclined on the slopes of this volcano. He concludes by remarking that the Demavend shows probably a double axis, such as was stated for instance on the Aetna by Sartorius and Ch. Lyell.—M. C. Paul reports on his investigations in the Karpathian Mountains made in this year. In Silesia he studied the so-called hieroglyphs of the Upper Tescheu slates, whose genesis is doubtful, but which are remarkable for their constantly keeping to a strictly limited level. He also gave a more exact division of Hohenegger's Iodula sandstone and fixed the position of the Irodek sandstone which Hohenegger had adjoined to the Lower Eocene (Nummulite group) as the highest division of the Eocene. In Western Galicia the gradual change of the petrographic facies of the Lower Karpathian sandstone (Neocomien) was studied. This formation consists in the northern zone of dislocation, chiefly of sandy and clayey strata, in the southern, which is called the penninic cliff-zone it shows a more limy composition. In Przemysl he visited the locality rendered important by Niedwieczky's discovery of ammonites. It was evident that the Neocomian ammonites were contained in a zone of those rocks called usually Ropiauka beds, which had been from other reasons already denoted as Neocomien. In Eastern Galicia the Karpathian sandstones could be divided into their proper groups and marked on the map, conformable to the results obtained by the reporter in the adjacent Bucovina. The sediments of the Karpathian sandstone divide here into the lower period (Ropiauca beds, Neocomian), the middle period (for the most part massy sandstones, probably middle Cretaceous), and the upper period, most certainly Eocene (to which belong sandstones containing Nummulites, the well-known fish-slates of Delatze, the Smilus slates, Schipoter beds, and the Magura sandstones of Czeruahora).

PARIS

Academy of Sciences, February 26.—M. Peligot in the chair.—M. Le Verrier reminded the Academy of the importance of watching on March 21, 22, and 23 for the possible transit of an intra-Mercurial planet across the sun. He also presented tome xiii. of *Annales de l'Observatoire de Paris*. This contains the theory of Uranus and Neptune, and M. Cornu's memoir on determination of the velocity of light between the Observatory and Montlhéry (by Fizeau's method improved). He finds this velocity 300,400 kilometres per second of mean time; the deduced solar parallax is 8″·88, 8″·88, or 8″·80, according as the number is combined with the equation of light given by Delambre (493″·2), with Bradley's constant of aberration (20″·25), or with that of Struve (20″·445).—M. Debray was elected member for the section of chemistry in place of the late M. Balard (the other candidates being M. Cloëz and M. Friedel).—Experiments on the origin and the nature of typhoid fever, by M. Guérin. He had in view the supposed direct influence of water-closets in producing the fever, and experimented on rabbits, injecting fecal matter, urine, blood, &c., from typhoid patients. He concludes (1) that such fecal matter contains, after issuing from the system, a toxical principle capable of causing death in a class of animals, in time varying from a few hours to a few days; (2) that the same holds for urine, blood, mesenteric liquid, and the detritus of mesenteric ganglions and of ulcerated intestinal mucus of typhoid subjects; (3) that these matters, after some months, are found to retain in large measure their original toxical principles; (4) that the fecal matters of healthy subjects or of those affected by other diseases have not the toxical principles which appear in excrementitial products of typhoid subjects.—On the effects of a jet of air in water, and on the suspension of water in air, by M. De Romilly. Among other experiments: Into a bell-jar, the mouth of which is closed with net, water is sucked up by means of a tube, with stopcock, entering the jar above. On closing the cock and raising the jar the liquid is retained, there being a meniscus at each mesh and a general meniscus. On inclining the jar the water flows out, but the smaller the mesh you may incline further without escape of liquid. Using metallic net, one may place a lighted gas jet under the suspended liquid, which will boil (gently) without falling down. (In this case the jar should be connected with another larger, the mouth of which rests in water.)—On the functions of leaves in the phenomena of gaseous exchanges between plants and the atmosphere; *rôle* of stomates, by M. Merget. He shows that the leaf functions of absorption and exhalation are arrested when a layer of varnish is formed on the face bearing the stomates. Thus the leaf may be subjected to mercurial emanations without absorbing a trace of the metal, which can, of course, be easily detected by photographic processes. On the other hand, if an ammoniacal liquid be injected into the leaf, the liberation of the dissolved gas by the face that has stomates is proved by the odour of this face, it white appearance when a rod dipped in hydrochloric acid is brought near, and its printing of paper sensitised with nitrate of mercury.—On ophthalmia, by M. Brame. He specifies twelve different categories and treatment.—New experiments to try for combating the phylloxera of the roots, by M. Rommier. He proposes salts or oxides of mercury, lead, copper, zinc, and others, dissolved in alkaline hyposulphites (potash or lime). Such compounds would not be acted on by the acids of the soil, like previous insecticides.—Determination of the lines of curvature of a class of surfaces, and particularly of the tetrahedral surfaces of Lamé, by M. Darboux.—Integrals of curves of which the developers by the plane and the developed by the plane are equal to each other, by M. Aoust.—Fourth note on the theory of the radiometer, by Mr. Crookes.—On the action of water on chlorides of iodine, by M. Schützenberger. If chlorides of iodine are not decomposed into hydrochloric acid, iodic acid, and free iodine, it is because the direction of the reaction is modified by the existence of a compound of hydrochloric acid and of protochloride of iodine stable in presence of water.—Formation of quinones by means of chlorochromic acid, by M. Etard.—On a saccharine matter extracted from leaves of walnut, by MM. Tanret and Villiers. The composition of the body is the same as that of *inosite*, but it has some special properties, and the authors name it (provisionally) *nucite*.—On the salts of the Algerian Chotts, by M. le Chatelier. They contain chloride of sodium and sulphate of soda; probably also carbonate of soda mixed with gypsum.—On three recent falls of meteoric stones in Indiana, Missouri, and Kentucky, by Mr. L. Smith.—Experiments on acute poisoning with sulphate of copper, by MM. Feltz and Ritter. These were made on frogs, pigeons, rabbits, and dogs. Sulphate of copper cannot be regarded as a harmless agent, though its introduction into the system does not, in the great majority of cases, cause death. No one would consent to swallow, in food or drink, the quantity that would prove fatal.—On the congestive and hæmorrhagic alterations of the brain and its meninges in birds, by M. Larcher.

CONTENTS

PAGE